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MEMOIRS
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THE GEOLOGICAL SURVEY OF INDIA.

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FIGURES AND DESCRIPTIONS OF THE ORGANIC REMAINS PROCURED DURING THE PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

PUBLISHED BY ORDER OF HIS EXCELLENCY THE GOVERNOR GENERAL OF INDIA IN COUNCIL.

Ser. XII.

THE FOSSIL FLORA OF THE GONDWÁNA SYSTEM.

Vol. IV.

Pt. 2. THE FOSSIL FLORA OF SOME OF THE COALFIELDS IN
WESTERN BENGAL.

(WITH PLATES I A—XIV A.)

By OTTOKAR FEISTMANTEL, M.D.,
Professor, Bohemian Polytechnic University, Prague.

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THE FOSSIL FLORA OF THE GONDWÁNA SYSTEM.

VOL. IV.

2.—THE FOSSIL FLORA OF SOME OF THE COALFIELDS IN WESTERN BENGAL.

BY OTTOKAR FEISTMANTEL, M.D.,

PROFESSOR, IMPERIAL ROYAL BOHEMIAN POLYTECHNIC HIGH SCHOOL, PRAGUE.

WITH PLATES IA—XIV A.

THE present memoir contains the results of two palaeontological excursions, which I undertook in the years 1881 and 1882-83, and during which I visited the following coalfields : North and South Káranpura in the Hazáribágh district ; the Auranga, Daltonganj and Hutár coalfields in Lohárdagga district ; I also passed through the Tatapáni coalfield in Sirguja, as well as through a great portion of the South-Rewah Gondwána Basin.

These coalfields having been already surveyed by officers of the Survey, I devoted my time especially to collecting fossils, for the purpose of completing our knowledge of the Gondwána flora in that region, and with the view of comparing the fossiliferous beds there with those of the other Bengal coalfields. I had pretty fair success, specially at some places ; I greatly increased the number of the Talebir fossils, collecting at three different places (in as many coalfields¹) ; I fixed, with much probability, the Karharbári horizon in two coalfields (Daltonganj and Hutár), and collected interesting fossils in the Barákars as well as in the upper-Gondwána of the Auranga coalfield.

The further details will be evident from the following account of the relations as I found them in the various coalfields.

THE KÁRANPURA COALFIELDS.

These coalfields are distinguished as the *Káranpura* and the *South-Káranpura* coalfields, the latter being much the smaller. They belong to the series of the

* * * * * North-Káranpura, Auranga and Hutár coalfields.

Damuda valley coalfields, the Damuda river traversing both of them. The geological description of these two fields by Mr. Th. Hughes¹ was published in 1871; they are situated to the west of the Jharia and Bokáro fields, to the south-west of the Hazáribágh plateau, in Pargana Káranpura, whence their name. At the time of the survey no fossils from the Damuda division were procured, but a few specimens were collected from the Talchirs of the Chano outcrops. I was somewhat more fortunate in procuring fossils from several localities in the former and adding considerably to the collection of fossils from the latter division.

I.—TALCHIR DIVISION.

A.—*Talchir group.*

The first fossils from the Talchir group of this coalfield were collected by Mr. Hughes (*l. c.*) and they were quoted by myself in my lower-Gondwána Flora.² They consisted however of a few specimens only, from the Talchir shales in the western extremity of the field, in the so-called Chano basin (north of Chano, north-west of Rikba and south of Lurunga).

When visiting the Káranpura coalfield in 1881 I especially intended to examine the locality where Mr. Hughes collected these Talchir fossils. For that purpose I encamped at Rikba, whence the Talchir outcrops are best accessible. At a point about three miles north-west from Rikba the road crosses a stream coming down from the hills north of Lurunga. Here the stream cuts through gneiss; but following its course to the south, the Talchirs soon set in, consisting at first (at base) of coarse conglomerate and quartzose sandstones; soon afterwards the Tordág stream (coming from the west, from the Tordág hills, passing by the village Indra) joins the Lurunga stream; somewhat further to the south a streamlet joins from the north-east, and just at this point there is a great display of Talchir shales, about 40 feet only from the base of the coal-beds (Barákars).

The Talchirs are here well exposed to a height of about 15 feet and consist in the lower part of some whitish-green sandy shales, while in the upper part the shales are rather brownish-green and somewhat softer than the former; both are however pretty rich in plant-remains, although they do not show a very great variety. I have collected the following fossils :—

Equisetaceous stalks, similar to those originally known from the Talchirs of the Karaun field (Bengal); it is rather difficult to determine their systematical position.

Filices. These show the most numerous representatives.

Gangamopteris, McCoy, forms the bulk of the fossils collected and shows a great variety of leaves. I distinguish :

Gangamopteris cyclopteroidea, Fstm. The typical Talchir form. Pl. VIA, figs. 1, 2; VIIIA, fig. 6; IXA, fig. 2. It exhibits several varieties.³

¹ Mem. Geol. Surv. of India, Vol. VII, Pt. 3, 1871.

² Fossil Flora of the Gondwána System, Vol. III, Pt. 1 and Pt. 2.

³ While distinguishing these varieties, I do not mean to say that they are quite different forms; I only want to indicate that they differ so widely in form from the type, that the application of a distinct name appeared necessary.

Gangamopteris cyclopteroidea, var. *subauriculata*. This seems the most numerous variety
Pl. VA, fig. 10; VIA, figs. 3, 4; VIIA, figs. 1-3, 6; VIII A, fig. 2; IXA, figs.
1, 3, 4, b, c; XA, figs. 1, 2, 4-7.

Gangamopteris cyclopt. var. *attenuata*, Pl. VIII A, fig. 1.

Gangamopteris cyclopter. var. *acuminata*. Leaves with peculiar triangular form, and thus a
pointed apex. Pl. VIIA, figs. 5 & 4 (?) ; VIII A, fig. 5 ; IXA, fig. 4a ; XI A, figs. 4, 7.

Gangamopt. cyclopter. var. *cordifolia*: Small cordiform leaflets which convey the idea as if
they belonged to a pinnate leaf. Pl. XI A, figs. 1, 3.

Gangamopteris obliqua, McCoy. Pl. XI A, figs. 2, 5.

Gangamopteris angustifolia, McCoy.

Gangamopteris comp. buriadica, Fstm. Pl. VIII A, fig. 7.

Gangamopteris major, Fstm. Pl. VA, fig. 9 ; XI A, fig. 9.

Nöggerathiac. Represented by the usual genus and species:

Nöggerathiopsis hislopi, Fstm. Pl. XII A, fig. 5, a.

Coniferac. A few remains.

Winged seeds : *Samaropsis*.

? *Coniferous branchlets*.—Pl. XII A, figs. 3, 4.

We have thus here a much greater variety of forms than previously obtained, and some are forms of the Karharbári beds in the Karharbári coalfield, showing still more the resemblance of the floras of these two groups of the Talchir division.

The Karharbári beds, however, were not met with in this coalfield; at least no beds were found, in which the fossils would indicate that age.

II.—DAMUDA DIVISION.

Previous to my visit no Damuda fossils were known from this coalfield. I procured fossils from all the groups, their relations being the same as in the Raniganj coalfield.

A.—Barákar group.

I collected fossils of this group at two places. First, close to the north-eastern margin of the field, in the Ghui or Bakwa river, about 1 mile south of the village Jugra, close to village Aráhura. The outcrops are exposed in the river bed, dipping south-west. The fossils were not many, and were contained in the coal seam and in the beds below it, in the following order:—

(a) In the coal seam, impressions of *Vertebraria indica*, Royle.

(b) Immediately below the seam, in dark-grey, somewhat sandy shales, impressions of *Vertebraria indica*, Royle, only; very numerous and good specimens.

(c) Below this; in a stratum of fine shale :

Vertebraria indica, Royle—less frequent.

Glossopteris indica, Schimp.

Glossopteris communis, Fstm.

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(d) In a stratum next below, in grey shale traversed by white worm like concretions :

- *Glossopteris communis*, Fstm., and
- Glossopteris indica*, Schimp.

The second locality where I collected Barákar fossils was further to the west in the Bishanpur river, $3\frac{1}{2}$ miles south-east from Bálumáth. This section, wherein three coal outcrops are exposed, has been described by Mr. Hughes in his report (*l. c.*) on page 25. It is situated in the western extremity of the coalfield. The fossils which I collected came from above the middle seam, from beds in the following order :—

(a) Above the seam, in dark-grey shale, partly sandy and micaceous :

- Vertebraria indica*, Royle—in great numbers ;
- Glossopteris communis*, Fstm. ;
- Glossopt. communis*, var. *stenoneura*—not uncommon.
- Glossopteris indica*, Schimp.
- Nöggerathiopsis hislopi*, Bünb. (Fstm.)
- Squamæ*—like some from the Barákars in the Raniganj field.

(b) Above this, in light, sandy, banded shale with fragmentary fossils :

- Vertebraria indica*, Royle, and other indeterminable fragments.

These fossils correspond with those from the Barákars in the Raniganj coalfield ; and this group is, in some places at least, separated from the Raniganj group by Ironstone-shales.

B.—Ironstone (shales).

There are Ironstone-shales cropping out in both the coalfields ; but I succeeded in procuring fossils from this band in South-Káranpura only. I collected at two spots on the Naikori or Jainagar river near to Jainagar, close to the southern margin of the field ; at the first spot, south of the village, the rock consists of clayey sphærosiderites, alternating with grey micaceous shales, both fossiliferous ; at the second in a ravine to the west of the village, the fossils occurred in brownish yellowish and reddish ferruginous shales. I collected the following :

- Equisetaceous stems*.—Affinity uncertain.
- Macrotetiopteris danaoides*, Royle.
- Glossopteris angustifolia*, Brtg.
- Glossopt. communis*, Fstm.
- Glossopt. indica*, Schimp.
- Glossopt. damudica*, Fstm.—Rather numerous ; a fragment of a very broad leaf figured on Pl. V A, fig. 6.
- Glossopt. retifera*, Fstm.
- Glossopt. conspicua*, Fstm.—Fragments.

Gangamopteris comp. *cyclopterooides*, Fstm.—Small circular leaflets, with radiating and anastomosing veins. (Pl. VA, fig. 7.)

Nöggerathiopsis hislopi, Fstm.

Squamæ.

This flora resembles entirely that of the Raniganj group in the Raniganj field, all the above-named forms being known there also.

C.—Raniganj group.

The Raniganj group also yielded fossils at two places, showing the same characters as in the Raniganj coalfield. The first place is in the northern portion of the field, 3 miles south-east of the Tandwa police station, in the Garhi or Chandra river, wherein a coalseam crops out, with a south-eastern dip.

The fossils occurred in the beds above the coalseam, *viz.*—

(a) in grey shales above the seam were observed :

Schizoneura gondwanensis, Fstm.

Vertebraria indica, Royle.

Cyathea comp. *tchihatchefi*, Schmalh.—Fragment of pinnae.

Glossopteris communis, Fstm.

Glossopt. indica, Schimp.

Glossopt. conspicua, Fstm.—Just like the form from near Asansol, Raniganj field.

Glossopt. formosa, Fstm.—Originally described from the Raniganj group of the Raniganj coalfield.

Dictyopteridium, sp.—Just like the leaflets described previously from the Barákar group (?) in the Talebir coalfield and from the Raniganj group, Raniganj coalfield.

Winged seeds—*Samaropsis*.—Like the same from elsewhere.

(b) Above the grey shales there is yellowish-grey sandstone, with *Glossopteris communis*, Fstm.

(c) Above this again massive greenish-grey sandstone with *Vertebraria indica*, Royle, traversing the sandstone in all directions, like the roots or rhizomes of some plant.

Above this *Vertebraria*-sandstone follow other sandstones, which most probably already belong to the Panchets, which here follow above the Raniganj group.

The other locality at which I collected fossils in the Raniganj group lies in the western portion of the field, *viz.*, in the Ganespur river, about $2\frac{1}{2}$ miles west of the village Bargaon, at the western extremity of the Satpáhri hill. There are three coal outcrops in the river, dipping almost north ; between the two northern ones there is a series of various beds, in which I collected fossils and which follow in ascending order (counted from the second to the third seam) thus :

(a) Shales accompanying the coalseam, containing :

Vertebraria indica, Royle.

FOSSIL FLORA OF THE GONDWÁNA SYSTEM.

(b) Grey sandstones above, with—

Glossopteris, sp. (veins not distinct).

(c) A series of sandstones and shales, without distinct fossils.

(d) A bed of grey shale, about 2 feet thick, with—

Glossopteris communis, Fstm.

Glossopteris angustifolia, Bgt.

(e) Immediately above is a series of greyish-brown shales, somewhat sandy and micaceous, full of fragments of leaves :

Glossopteris angustifolia, Bgt.

Glossopteris damudica, Fstm.

Glossopt. retifera, Fstm.

Glossopteris authrophyoides, n. sp.

Squameæ—like those from the Raniganj group, Raniganj coalfield.

(f) Again grey shales with—

Glossopteris communis, Fstm.

(g) Greenish shales without fossils.

(h) Then a bed about 3 feet thick, of reddish-white hard shales, full of vegetable fragments, amongst which—

Vertebraria indica, Royle.

Glossopteris indica, Schimp.

(i) At last sandy shales, with—

Vertebraria indica, Royle.

No fossils occurred with the two other outcrops at this locality.

The higher horizons (Panchets and Mahádevas) also did not yield any fossils.

THE AURANGA COALFIELD.

This coalfield, which lies to the west of the Káranpura coalfield, was surveyed by Mr. Ball,¹ who at the same time made a very interesting palaeontological observation, viz., that several species of plants, hitherto considered as of lower-Gondwána type, occurred in certain red shales of apparently Mahádeva age. I therefore visited this coalfield for the purpose of searching this interesting locality, among others.

I.—TALCHIR DIVISION.

A.—Talchir group.

On the northern face of the Latiahar hill, about $1\frac{1}{2}$ miles north-east of Tappa-Latiahar, I came across an exposure of bedded rocks, about 8 feet high, reddish with yellowish-greenish tints, which on closer examination I found to contain

¹ Mem. Geol. Survey of India, Vol. XV, Pt. 1, 1878.

Talchir fossils. These beds are the Talchirs between Batiahar and Nowadih, described by Mr. Ball on pp. 56 and 57 of his report (*l. c.*), but the fossils were new I determined the following :

Equisetaceous stalks.

Gangamopteris cyclopteroidea, Fstm. The type form Pl. XII A, fig. 17; XIII A, fig. 1.

Gangamopt. cyclopteroidea, var. *subauriculata*. Pl. X A, fig. 3; Pl. XIII A, figs. 3, 7. The first figure (Pl. X A, fig. 3) represents an entire leaf of small size, but with all the characters of the species.

Gangamopt. cyclopt. var. attenuata. Pl. XIII A, figs. 4, 6.

Gangamopt. cyclopt. var. acuminata.

Gangamopt. cyclopt. var. cordifolia. Pl. XIII A, figs. 16, 18; Pl. XIII A, fig. 2.

Nöggerathiopsis hislopi, Fstm. Pl. XIII A, fig. 5.

Samaropsis.—Winged seeds.—Like those from other localities. Pl. XII A.

Gangamopteris in its various forms is thus again here the predominant fossil, although the leaves are on the whole somewhat smaller than those from the Chano-basin in the Kárapura coalfield.

II.—DAMUDA DIVISION.

A.—Barákar group.

I examined the outerops within this group at four different places ; one locality yielded a good number of fossils and proved of great interest.

I visited at first the Barákar outerops in the small outlier to the north of Bálunagar (at the eastern extremity of the field) about 2 miles distant. Mr. Ball describes this outlier on pp. 79-82 of his report (*l. c.*). In the river close to north-west of the village of Dhurdhuria I collected fragmentary fossils from the outcropping beds in ascending order as follows :

(a) From the coal seam :

Vertebraria indica, Royle.

(b) From iron band above :

Glossopteris sp.—fragments.

(c) From grey shales above this :

Vertebraria indica, Royle.

Glossopteris communis, Fstm.

Near Murup, west of Bálunagar, there are some outerops in the Sukri river and adjoining ravines, close to the village of Dhobiajharan.

I found only *Vertebraria indica*, Royle, in most of the layers, but previously, Mr. Griesbach had collected, apparently at the same place, a few fossils, amongst which I recognised :

Trizygia speciosa, Royle.

Glossopteris communis, Fstm.

Similar relations were met with in the southern portion of the field, near Taguldagga, in the Aurangā river and the tributary stream south-east of the village. The

fossil remains consisted of *Vertebraria indica*, Royle, only, though they were found in all the outcrops.

The best and most interesting fossils were found in the outcrops in the Sukri river west of village Gurtur, north-west of Serak, in the eastern portion of the coal-field. I collected fossils at two places in the said river, and it will thus not be without interest to give an account of both separately.

The first spot is in the Sukri river, to the west of Gurtur also, but closer to the village of Rajbar, about $\frac{1}{4}$ mile north-east of the same. The fossiliferous strata there (dipping south-west) are the following, in ascending order :

(1) The seam is exposed on the right bank of the river covered by—

(2) dark-grey shale, about 2 feet thick and full of—

Vertebraria indica, Royle.

The rest of the section is exposed across the river, on the left bank, beginning below in the river with the dark-grey shales (2), followed by :

(3) Light grey shales, about 4 feet thick, containing :

Vertebraria indica, Royle.

Glossopteris, sp.

(4) Then follows a complex of shales, ironstone, ferruginous sandy shales and ferruginous sandstones, which all, no doubt, constitute the same bed, but which may be subdivided as follows (in ascending order) :

(a) Below, brownish yellowish grey shales, about 1 foot thick, resembling a similar shale of the Barákar group from near Talchir, in the Talchir coal-field, full of fossils :

Vertebraria indica, Royle.

Schizoneura gondwanensis, Fstm.—Fragments of the leaf sheath.

Glossopteris communis, Fstm.

Glossopteris indica, Schimp.

Glossopteris damudica, Fstm. (Pl. IV A, fig. 1, right figure.)

Glossopt. retifera, Fstm. (Pl. IV A, fig. 1, left figure.)

Glossopt. angustifolia, Bgt.

(b) Brown and purple sandy ironstone band, with concretionary structure, containing :

Glossopteris communis, Fstm.

(c) This is succeeded by a greyish sandy shale with—

" " *Vertebraria indica*, Royle, in a peculiar state of preservation which will be noticed hereafter.

(d) These sandy shales pass into bedded somewhat ferruginous sandstones, with :

Glossopteris communis, Fstm.

Glossopt. indica, Schimp.

(5) Light grey shales with *Vertebraria* and *Glossopteris*.

(6) Yellowish shales conclude the section above.

The second spot is also in the Sukri river, south-east of the former, about $\frac{3}{4}$ mile west of Gurtur, where a good number of fossils were found, which proved of great interest. They were also at this spot taken from various beds, which follow in ascending order thus :

(1) The lowest bed seen is grey sandy shale with :

Vertebraria indica, Royle.

(The coal seam lies somewhat more to the east dipping below this bed.)

(2) Above this, ferruginous sandstones with—

Glossopteris communis, Fstm.

The veins of the leaves in this sandstone are of red colour and the whole has somewhat the appearance of Kámthi sandstones.

(3) A series of crushed shales of bluish-grey and brownish colour, with ferruginous sandstone at the base, and also interbedded with the same.

The sandstones contain—

Vertebraria indica, Royle, in the same state of preservation as in bed 4c of the previous section (Pl. IVA, figs. 4, 5, 7-11; Pl. VA, fig. 1.)

Glossopteris communis, Fstm.—like those in the preceding bed.

In the crushed shales were observed—

Vertebraria indica, Royle, as above.

Glossopteris communis, Fstm.

Glossopt. indica, Schimp.

Glossopt. damudica, Fstm.

Towards the top, these crushed shales pass into—

(3a) lenticular layers of shales of light bluish-grey or reddish-grey colour, which contained a most peculiar association of plants :

Macrotæniopteris seddenei, Fstm. Pl. IA fig. 1. One large leaf.

Macrotæniopt. danæoides, Royle. Pl. IVA, figs. 2, 3.

Glossopteris communis, Fstm. Pl. IIA, figs. 1, 2, 1a, 2a.

Glossopt. indica, Schimp.

Glossopt. browniana, Bgt. Pl. IA, figs. 2, 2a.

Glossopt. damudica, Fstm. Pl. IA, figs. 3, 3a.

Gangamopteris, sp. Pl. IIA, figs. 3, 3a.

Platypterygium (Anomozamites) balli, n. sp. Pl. IIA, figs. 4, 4a; 5-7, 7a; 8; 8a, b; IIIA, fig. 2 (leaflet in upper right corner).

Rhipidopsis gingkooides, Schmalb. Pl. IIIA, figs. 1, 2.

Cyclopitys (?) dichotoma, n. sp. Pl. IIIA, figs. 3, 4; IVA, fig. 6.

(4) Again a ferruginous sandy band with—

Glossopteris communis, Fstm.—reminding again of Kámthi specimens.

This collection of plants contains not only forms which are chiefly numerous in higher groups of the Damuda division, but also others which elsewhere are known from still higher beds (jurassic, in Siberia). Yet there seems from stratigraphic

physical reasons no doubt, that this section exposes beds of the Barákar group, as it was mapped and described by Mr. Ball for that part of the coalfield.

The fossils are described more in detail hereafter.

B.—Raniganj group.

There are outcrops at several places in the Raniganj group, but they did not prove very fossiliferous. While encamped at Murup, I visited the outcrops in the Sukri river west of Tubed (which itself is again west of Murup); but here no fossils were found. I therefore examined other outcrops, *viz.*, in the small area north of Taguldagga, in the river bed traversing that area from east to west. The outcrops dip here to the south and the beds exposed below the coalseam were: close bedded grey sandstone, grey sandy shales and grey carbonaceous shales. These latter contained numerous fossils, but it was rather difficult to secure good specimens, as the shale crops out in the river bed itself and is soaked with water. I could determine the following fossils:

- Schizoneura gondwanensis*, Fstm.
- Vertebraria indica*, Royle.
- Macrotetrapteris danoides*, Royle.
- Glossopteris angustifolia*, Bgt.
- Glossopteris communis*, Fstm.
- Glossopteris conspicua*, Fstm.
- Sanamae*.

The rock in which these fossils were contained very much resembled that from the Raniganj beds south of Tandwa, in the Káranpura coalfield, as well as that in the Numia river, north-west of Asansol, having similar fossils, as also similar relations with regard to the overlying Panchet rocks; these relations in this coalfield are sufficiently described by Mr. Ball, pp. 82, 83 *et seq.* (*l. c.*); from his description it appears that there is no marked unconformity between these two groups.

III.—TRANSITIONAL BEDS, like MÁHADEVAS.

It is in this coalfield that the interesting beds of apparently upper-Gondwána age, with lower-Gondwána fossils, were first observed by Mr. Ball, who brought some fossils from the beds in question, including *Vertebraria*, *Glossopteris*, *Pecopteris*, peculiar scales and small seeds—fossils which up to that time were known from the Damudas only. Mr. Ball quoted this locality under the heading of “Máhadeva Series”, (*l. c.* p. 89), but he did not assign the beds positively to the Máhadevas. It was thus of great interest for me to visit the locality whence these specimens were procured. It is on the northern face of the Latiahar hill, north-east of Tupa-Latiahar, close to the Talchir beds already mentioned.

Pieces of this red shale were met with at once at the foot of the hill, especially in the ravines. Following them up the hill, they increased in size and number. Petrographically they showed different varieties: some pieces were very fine grained

and tough, others soft and micaceous. Some pieces I found adhering to a loose reddish sandstone of Mâhadéva type. At a certain horizon, about 30 or 40 feet below the crest of the hill, the debris of shales disappeared, so that it could not have come from above this horizon. In following up that line below the crest of the hill further to the east, I arrived at a scarp, about 15 feet high, of sandstone *in situ*, apparently the same Mâhadéva sandstone, of which the main part of the hill was composed, a coarse brownish red sandstone. Below it there was a bed of about 6 inches of red shale of the micaceous variety and entirely the same as the fossiliferous pieces found on the hill slope, so that, although at this spot I could not observe any fossils in it (it was badly accessible for work) I have no doubt that it represented a portion of the shale bed from which the pieces lying all over the hill slope were derived. It would thus appear that these shales are really in close connection with the sandstone of the hill, which bears so close a resemblance to Mâhadéva sandstone; I therefore include them under the section of my Transitional beds (*supra*, Pt. 1, p. 5).

The fossils I collected included some forms in addition to those brought by Mr. Ball, so that the list of fossils from here stands now thus:

Schizoneura gondwanensis, Fstm.—A portion of the sheath only, but the commissural lines of the leaflets, as well as their middle veins are well seen.

Vertebraria indica, Royle.—Usual form.

Glossopteris communis, Fstm.

Glossopteris indica, Schimp.

Glossopteris damudica, Fstm.

Gangamopteris sp.—Several small spatulate leaflets, with radiating and anastomosing venation.

Scales.

Winged seeds.

Similar relations, showing lower-Gondwâna (Damuda) plants passing into rocks of apparently upper-Gondwâna (Mâhadéva) age, were also observed by Mr. Hughes in South Rewah, first at a place called Parsora (near Beli) in the Sohâgpur area, where he collected several interesting fossils, preserved in a red shale very much resembling that from the Latiahar hill and amongst which I recognized specimens of *Nöggerathiopsis hislopi*, Bünb. (Fstm.). At another place, *viz.*, Daigaon on the Johilla river, *Vertebraria* and *Glossopteris* occurred and yet the stratigraphical relations demand for the beds of these places a higher position than the Damudas. It was for these beds, which Mr. Hughes called *Supra-Barakars* that I proposed a separate division, *viz.*, *Transitional Beds*¹ and I see that in his last report Mr. Hughes² concurs in my proposal.

THE HUTÁR COALFIELD.

Further to the west, traversed by the Koel river, lies the Hútár coalfield, which also was surveyed and described by Mr. Ball. The relations here are somewhat

¹ Flora of S. Rewah. Pal. Ind.: Gondwâna Flora, IV, 1, 1882, p. 5.

² Mem. G. S. I., XXI, Pt. 3, p. 72. [See *infra*, note 2 p. 58.]

different from those in the preceding coalfields ; we do not find here the Raniganj group, but on the other hand there are representatives of the Karharbāri beds to be met with.

I examined first the outcrops at the northern margin of the field, south of the village Nowadīh, close by the road which leads in a directly southern direction from Daltonganj. At this northern margin the coalbearing strata are in contact with the Talchir rocks. About $2\frac{1}{2}$ miles south of Nowadīh the road crosses a streamlet, which joins the Supuhi river (this latter falling into the Koel river $1\frac{1}{2}$ miles to the eastward). In this streamlet the seams crop out. Following up in a northern direction from the crossing of the road, at first several outcrops are found between massive sandstones, with a southern dip ; here *Vertebraria indica*, Royle, only was found.

Further on (northwards) quite close to the junction of the coalbearing rocks with the Talchirs there are some other outcrops of strongly carbonaceous shales, in which the following fossils occurred :

Gangamopteris cyclopterooides, Fst.m.

Gangamopt. cyclopt. var. *attenuata*.

These carbonaceous shales pass without break into strata belonging to the Talchirs and are conformable with them. Here the following fossils were observed :

Equisetaceous stems.

Gangamopteris cyclopterooides, Fst.m.; the typical form.

Gangamopt. cyclopt. var. *subauriculata*.

Thus it appears that at this place there is a sequence of three different groups. If the last mentioned belong to the Talchir group, then the carbonaceous shales in close proximity to them most probably represent the Karharbāri beds, while the higher outcrops (with *Vertebraria indica*) would have to be considered as representing the Barákar group. These relations were, however, observed in this part of the coal-field only, while the fossils from the other outcrops indicated rather the Barákar group.

To the east of Nowadīh, but also close to the northern margin of the field, at the village Hütár, there are again some coal outcrops in a streamlet ; they are also apparently in conformity with the Talchirs there, but the fossils procured were only very few and fragmentary, representing—

Equisetaceous stems (Phyllothecca ?)

Glossopteris sp. (comp. *communis*), ..

so that it appears safer to consider these outcrops rather of Barákar, than of Karharbāri beds, in spite of their closeness to the Talchirs.

Somewhat better fossils were met with in the eastern portion of the field, near the south-eastern margin, at the confluence of the Dauri and Ghorsum streams, north of Saidope village. There is a good display of beds ; at the bottom of the section, close to the river surface is coal, over it lies coaly shale, then grey sandy shales, above which follow sandstones of yellowish and reddish colours.

The fossils occurred, in good numbers, in the black coaly shale above the coal and the following could be recognised :--

Equisetaceous stems.—Very numerous (probably *Phyllotheeca*).

Glossopteris indica, Schimp.

Glossopteris damudica, Fstn.

Coniferous branch, like *Voltzia*.

These coalseams also belong, according to the fossils, to the Damuda division, and with regard to the stratigraphy, to the Barákar group.

I visited also the outcrops, near Mundul, on the southern margin of the coalfield ; close by the road from Daltonganj and near the Koel river ; but did not find any fossils there.

The last visited were the outcrops in the Satghuria river, near Bijka, at the north-western margin of the coalfield ; here *Vertebraria indica*, Royle, occurred in grey shale in one of the higher outcrops.

The interesting occurrence of Talchir, Karharbári and Barákar fossils in succession is thus limited to the outcrops close to the northern margin south of Nowadih, while the other outcrops show only characters of the Damuda division (Barákar group).

THE DALTONGANJ COALFIELD.

To the north of the Hútár coalfield, or about 50 miles west of Házáribágh, is situated the Daltonganj coalfield, traversed by the Koel and Amánat rivers ; the former in the central and western and the latter in the eastern portion of the field. The greater portion of the Gondwána area is occupied by Talchir rocks, but no fossils have been found in them, neither by Mr. Hughes, who surveyed the coalfield,¹ nor by myself. In the middle of it there is a considerable coalfield, and according to the fossils I collected these measures belong to the Karharbári beds. I examined the chief outcrops of the coalfield with the following results.

1.—OUTCROPS AT SINGRA.

Close to the junction of the Koel and Amánat rivers, near the village Singra, where mining is carried on to some extent, about 5 miles north of Daltonganj, there is in the bed of the Amánat a good exposure of the coalbearing rocks, consisting of sandstones and sandy shales, with outcrops of three coalseams, which in this description I shall distinguish in ascending order as 1st, 2nd and 3rd seam.

The base of the section (below the 1st seam), close to the river surface, consists of a series of sandy micaceous grey shales, which, on the whole, are unfossiliferous, excepting a band almost at the base, in which leaf impressions occurred, amongst which I could determine the following :

Gangamopteris cyclopteroidea, var. *attenuata*.

Glossopteris communis, Fstm.—Large leaves.

Glossopteris indica, Schimp.

The stratum immediately above this bed contained root-like impressions traversing the rock in various directions; in some cases they appeared to me to be of *Vertebraria*. Above this bed lies the first coal outcrop.

Upon this follows a series of sandstones and shales, without any trace of fossils, underlying the second seam.

Above this second seam lies a stratum of grey sandy shales, with a band of hard and light grey shale.

The third seam, which now follows, is not exposed in this section on the river, but a little further to the south, where in a soft, fine shale, of grey colour with redish tints, above this seam, the following fossils were found:

Vertebraria indica, Royle.

Nöggerathiopsis histopi, Bünb. (Fstm.)—Numerous.

Winged seeds (*Samaropsis parvula*, Heer).

Though the fossils of this seam are not quite decisive, yet I think they belong together with those of the 1st seam to the Karharbári horizon, exhibiting relations similar to those of the 1st and 3rd coalscums in the Karharbári coalfield.

The Karharbári character of the fossils is however more distinctly expressed in another outcrop to the north of Singra.

2.—OUTCROPS AT RAJHERA.

There are other outcrops, near Rajhera, about $4\frac{1}{2}$ miles north-west of Singra, which yielded a good number of fossils. In a stream bed south of Rajhera the outcrop consists at first of sandstones like those above the first seam at Singra. Below these sandstones there are grey micaceous sandy shales about 5 feet thick and in about the middle of them there is a band of dark grey coaly shale, which breaks irregularly with somewhat a spheroidal structure, and which, I think, represents the first (lowest) seam at Singra. In this dark shale band numerous fossils occurred, which on the whole were very well preserved and which represented the following species:

Glossopteris communis, Fstm.—Some very large leaves. (Pl. XIV A, fig. 7.)

Glossopteris indica, Schimp.—Also large forms.

Glossopteris decipiens, Fstm.—Like those from the Karharbári coalfield.

Gangamopteris cyclopterooides, Fstm.—The typical form. (Pl. XIV A, figs. 1-4.)

Gangamopt. cyclopter. var. *subauriculata*.—One specimen with doubled up margin. (Pl. XIV A, fig. 5.)

Gangamopt. cyclopter. var. *attenuata*. (Pl. XIV A, fig. 6.)

Samaropsis (comp. *parvula*, Heer).—Like those from the Karharbári beds. (Pl. XIV A, figs. 8, 9.)

Coniferous branchlet (=? *Voltzia*).

There is hardly any doubt of the Karharbári character of these outcrops.

Other outcrops occur east of Rajhera which however did not yield many distinct fossils, except :

Equisetaceous stems.

Glossopteris communis, Fstm.

In spite of this, I think there can be hardly any doubt that the coalbearing rocks of the Daltonganj coalfield belong to the Karharbári horizon, and that the Daltonganj coalfield itself is an analogue of the Karharbári coalfield.

RAMKOLA AND TATAPÁNI COALFIELD.

To the west of the Hútár coalfield lie the Ramkola and Tatapáni fields in the eastern prolongation of the great South-Rewah Gondwána basin.

The Ramkola and Tatapáni coalfield was surveyed by Mr. Griesbach,¹ who collected a good number of fossils from the various horizons of the lower-Gondwána. I reported on these fossils in 1880.² Mr. Griesbach distinguished stratigraphically the Talchir, Barákar, Ironstone, Raniganj and Panchet groups of the lower-Gondwána, and the Máhadévas.

As an interesting fact, I had then pointed out (*l. c.* p. 66) that in this area again the close palaeontological relation of the several groups is clearly illustrated, especially with regard to the Raniganj and Panchet groups; for there were fossils from several localities, which for themselves would rather indicate the Raniganj group, while from a stratigraphical point of view they seemed to be in the Panchet horizon.

Another point of interest was also noticed (*l. c.* p. 66), viz., the numerous occurrence of *Schizoneura gondwanensis*, Fstm., in beds assigned by Mr. Griesbach to the Raniganj group; it occurred in similar rocks and under similar circumstances as in the Raniganj group of the Raniganj coalfield, thus yielding satisfactory proof in favour of Mr. Griesbach's grouping.

As my stay in this coalfield was but short I have nothing to add of importance.

THE SOUTH-REWAH GONDWÁNA BASIN.

The fossils of the great South-Rewah Gondwána basin, which had been so far collected by Mr. Hughes during the progress of his survey were described and figured by myself in 1882.³ There were many interesting forms; amongst others

¹ Mem. Geol. Survey of India, Vol. XV, Pt. 2 (1880).

² Rec. Geol. Survey of India, Vol. XIII, Pt. 1, pp. 65 *et seq.*

³ The Fossil Flora of the Gondwána System, Vol. IV, Pt. 1, Palaeont. Indica, Ser. XII.

the fossils from Parsora near Beli, and Daigaon (*l. c.* pp. 5-7), which of themselves indicate a lower-Gondwána horizon, while stratigraphically they occupy a higher horizon, and belong to the section "Transitional beds" described before; I see that in his recent report (Mem. Geol. Survey India, XXI, Pt. 3), Mr. Hughes places also some other localities in this category.

In addition to the illustrations already given in my former paper I figure now a specimen of *Vertebraria indica*, Royle, which is so far interesting as coming from Talchir rocks; it was collected by Sub-Assistant Hira Lal (in 1882), in fine light yellowish green shale, belonging to the Talchirs, in the river bed south of Behia-Bargaon, 18 miles north-east of Anukpúr (26 miles south-east of Sohagpúr). The specimen is figured on Pl. XIII A, fig. 8.

I visited also the outcrops in the Umaria coalfield near Umaria-Kalesar, in the western portion of the Rewah basin, where I collected :

Vertebraria indica, Royle (below coal).

Gangamopteris cyclopterooides, Fstm.

Nöggerathiopsis hislopi, Fstm.

These fossils seem to me to indicate the Kaharbári horizon but Mr. Hughes has not distinguished them from the Barákars in his description of these coal-fields.

From Umaria I passed on to Kouria (to the north-west), whence I visited the outcrops of the Jabalpur group in the Machrar river, near Bansa, north of Kouria. The beds exposed there consist in ascending order, of (a) sandstones, (b) light shales (yellow and purplish), (c) sandstones, and (d) black shales. I collected a few fossils in both kinds of shales : *viz.* (a) in light shale :

Podozamites lanceolatus, L. and H.

Araucarites entchensis, Fstm. (scales).

Brachiphyllum mammillare, Bgt.

(b) In black shale :

Gleichenia rewakensis, Fstm. (fragments).

Podozamites lanceolatus, L. and H.

Araucarites entchensis, Fstm. (scales).

Echinostrobus expansus, Schimp.

Brachiphyllum mammillare, Bgt.

As the same fossils from the Jabalpur group and from the same locality have been already described, partly in my Jabalpur Flora,¹ partly in the Flora of the South-Rewah Gondwána Basin (*l. c.*), I shall not include them amongst the fossils to be described here, so that the descriptions refer only to the fossils of the first named four coalfields.

¹ Fossil Flora of the Gondwána System, Vol. II, Pt. 2, Palaeont. Ind., Ser. XI.

GENERAL LIST OF FOSSILS.

NAME OF FOSSILS.	LOWER PORTION.								UPPER POR- TION. <i>Transitional beds like Máhadevas.</i>
	Talchir division.				Damuda division.				
	Talchir group.	Karharbúri beds.		Barákar group.	Ironstone shales.	Raniganj group.			
	Káranpura.	Auranga.	Hutár.	Daltonganj.	Káranpura.	Auranga.	Hutár.	South Káran- pura.	Auranga.
I.—EQUISETACEAE.									
<i>Schizoneura gondwanensis</i> , Fstn.									
<i>Phyllotheeca</i> sp. (doubtful) (Pl. XII A, figs. 3, 4)	+								
<i>Trizygia speciosa</i> , Royle									
<i>Vertebraria indica</i> , Royle									
II.—FILICES.									
<i>Cyathea</i> comp. <i>tchihatchefi</i> , Schmalh.									
<i>Macrotæniopteris</i> <i>dawsonoides</i> , Royle (Pl. IV A, figs. 2, 3)									
<i>Macrotæniopt. feddei</i> , Fstn. (Pl. I A, fig. b)									
<i>Glossopteris angustifolia</i> , Bgt. (Pl. VA, fig. 5)									
<i>Glossopt. communis</i> , Fstn. (Pl. XI A, figs. 6, 8; Pl. XII A, fig. 1; 5, b; 6a; Pl. II A, figs. 1, 2, 1a, 2a)	+								
<i>Glossopt. communis</i> , var. <i>steno-</i> <i>neuro</i>									
<i>Glossopt. indica</i> , Schimp.									
<i>Glossopt. browniana</i> , Bgt. (Pl. I A, figs. 2, 2a)									
<i>Glossopt. domudica</i> Fstn. [Pl. IV A, fig. 1 (right figure), Pl. I A, figs. 3, 3a; Pl. V A, fig. 6]									
<i>Glossopt. reticulata</i> , Fstn. [Pl. IV A, fig. 1 (left figure)]									
<i>Glossopteris conspicua</i> , Fstn.									
<i>Glossopt. formosa</i> , Fstn.									
<i>Glossopt. decipiens</i> , Fstn.									
<i>Gangamopteris cyclopteroidea</i> , Fstn. (Pl. VI A, figs. 1, 2; Pl. VIII A, fig. 6; Pl. IX A, fig. 2; Pl. XII A, fig. 17; Pl. XIII A, fig. 1)	+	+	+	+					
<i>Gangamopteris cyclopteroidea</i> var. <i>subauriculata</i> (Pl. V A, fig. 10; VI A, figs. 3, 4; VII A, figs. 1—3, 6; VIII A, fig. 2; IX A, figs. 1, 3, 4, b, c; X A, figs. 1, 2, 4—7; XIV A, fig. 5)	+	+	+	...	+				

GONDWĀNA SYSTEM IN INDIA.

NAMES OF FOSSILS.	LOWER PORTION.								UPPER PORTION.	
	Talehir division.				Damuda division.				<i>Transitional beds like Mahādevas.</i>	
	Talehir group.	Kurharbāri beds.	Borākar group.	Ironstone shales.	Raniganj group.					
	Kāranpura.	Aurangz.	Hutár.	Hutár.	Daltongaj.	Kāranpura.	Aurangz.	Hutár.	South Kāranpura.	Aurangz.
<i>Gangamopteris cyclopteroidea</i> var. <i>attenuata</i> (Pl. VIII A, fig. 1; IX A, fig. 4, a; XIII A, figs. 4, 6)	+	+	-	+	+	-	-	-	-	-
<i>Gangamopteris cyclopteroidea</i> var. <i>acuminata</i> (Pl. VII A, fig. 5, 4 (?) ; VIII A, fig. 5; XI A, figs. 4, 7)	+	+	-	-	-	-	-	-	-	-
<i>Gangamopt. cyclopteroidea</i> var. <i>cordifolia</i> (Pl. XI A, figs. 1-3; XIII A, figs. 16, 18; XIII A, fig. 2)	+	+	-	-	-	-	-	-	-	-
<i>Gangamopteris comp. cyclopteroidea</i> , Fstn. (Pl. V A, fig. 7)	-	-	-	-	-	-	-	-	+	-
<i>Gangamopteris obliqua</i> McCoy (Pl. XI A, figs. 2, 5)	+	-	-	-	-	-	-	-	-	-
<i>Gangamopt. angustifolia</i> McCoy	+	-	-	-	-	-	-	-	-	-
<i>Gangamopt. comp. buriadica</i> , Fstn. (Pl. VIII A, fig. 7)	+	-	-	-	-	-	-	-	-	-
<i>Gangamopt. major</i> , Fstn. (Pl. V A, fig. 9; XI A, fig. 9)	+	-	-	-	-	-	-	-	-	-
<i>Gangamopteris</i> sp. (?) (Pl. II A, figs. 3, 3a)	-	-	-	-	-	-	+	-	-	+
<i>Gangamopt. anthrophyoides</i> , Fstn. (Pl. V A, fig. 4)	-	-	-	-	-	-	-	-	-	-
<i>Dictyopteridium</i> , sp. (Pl. V A, fig. 3)	-	-	-	-	-	-	-	-	-	-
III.—CYADEACEAE.										
<i>Platypergium ballii</i> , Fstn. (Pl. II A, figs. 4, 4a; 5-8, 7a, 8a, b; III A, fig. 2 - leaflet in upper right corner)	-	-	-	-	-	-	+	-	-	-
<i>Naggerathiopsis histopis</i> , Bumb. (Fstn.) (Pl. XII A, fig. 5, a; Pl. XIII A, fig. 5)	+	+	-	-	+	+	-	-	+	-
IV.—CONIFERA.										
<i>Volzia</i> (doubtful)	-	-	-	-	+	-	-	-	-	-
<i>Rhipidopsis gingkoides</i> , Schmahl. (Pl. III A, figs. 1, 2)	-	-	-	-	-	-	+	-	-	-
<i>Cyclopitys</i> (?) <i>dichotoma</i> n. sp. (Pl. III A, figs. 3, 4; IV A, fig. 6)	-	-	-	-	-	-	+	-	-	-
<i>Samaropsis</i> (winged seeds) (Pl. V A, fig. 8, a-e; XII A, figs. 7-15; XIV A, figs. 8, 9)	+	+	-	-	+	-	-	-	+	-
<i>Squamaria</i> , (Pl. V A, fig. 2)	-	-	-	-	-	+	-	-	+	-

LIST OF LOCALITIES ACCORDING TO GROUPS.

I think, it will be convenient, to give here a list of the various localities at which fossils were collected, arranged according to the different groups, so that when hereafter the various localities have to be quoted in connection with the fossils, they can easily be found.

I.—TALCHIR DIVISION.

A.—*Talchir group.*

Behia-Bargaon, 18 miles north-east of Anukpur, which is 26 miles south-east of Sohágpur. Collect. Hira Lal, 1880.—Quoted here again on account of the specimen of *Vertebraria indica*, Royle, which was mentioned already in my South-Rewah Flora (*l. c.*) ; but the figure of which is given here for the first time (Pl. XIII A, fig. 8).

Latiahar hill, northern base of; 1½ miles north-east of Tappa-Latiahar, sub-division Palámow, Lohárdagga district, Auranga coalfield. Collect. Feistmantel, 1881.—Fossils quoted already on a previous page ; contained in soft, sandy rock, reddish, with yellowish and greenish tints. A new addition to the fossils of the Talchir group.

Nowadiah, stream south of, at the northern margin of the Hutár coalfield, close to the road which leads from Daltonganj southwards. Collect. Feistmantel, 1883.—Fossils (see above) in grey-brownish, earthy, somewhat sandy shale.

Rikba, 2 miles west-north-west of ; in Chano basin, eastern portion of the Káranpura coalfield ; in the river formed by the junction of the Lúrunga and Tordág streams, about 16 miles south-by-west of Hazáribágh.—A few specimens were originally collected by Mr. Hughes and figured in my Flora of the Talchir and Karhabári beds. All the specimens figured in the present memoir were collected by myself in 1881.

B.—*Karhabári beds.*

Nowadiah, same locality as above under Talchir group. Fossils in black somewhat micaceous shales, immediately above Talchir rocks. Collect. Feistmantel, 1883.

Rajhera, south of, in the Daltonganj coalfield ; in grey sandy and dark carbonaceous shale (representing the first coalseam). Collect. Feistmantel, 1883.—Fragmentary fossils occurred also in outcrops east of this place.

Singra, in Daltonganj coalfield ; outcrops at junction of Koel and Amánat rivers, about 5 miles north of Daltonganj. Collect. Feistmantel, 1883.—Fossils in grey sandy shale, below 1st seam. Also, at the same locality, above 3rd seam.

Umaria coalfield, outcrops near Umaria-Kalesar, in South Rewah. Mr. Hughes has not separated these coal beds from the Barákar group.

II.—DAMUDA DIVISION.

A.—*Barákar group.*

Arápura, near, in Ghui river ; 1 mile south-by-east of Jugra, 11 miles south-west of Hazáribágh, north-eastern portion of Káranpura coalfield. Collect. Feistmantel, 1881. . .

Bishanpúr river, $3\frac{1}{2}$ miles south-east of Balúmáth and 1 mile north-west of Belwadih village, north-western part of Káranpura coalfield. Collect. Feistmantel, 1881.

Bálunagar, outlier, at the north-eastern extremity of and $1\frac{1}{2}$ mile to the north from the Auranga coalfield, Palámow, Lohárdagga. Collect. Feistmantel, 1881.

Hutár, outcrops at, in the Hutár coalfield, south of Daltonganj coalfield. Collect. Feistmantel, 1883.—Fossils in earthy, somewhat sandy, dark grey-brownish shale, not very distinct.

Jaguldagga, south and south-east of (about $6\frac{1}{2}$ miles east of Tappa-Latiahár), in Auranga river and eastern affluent; Auranga coalfield. Collect. Feistmantel, 1881.

Murup, west of, in Sukri river; northern margin of the Auranga coalfield (Murup is $4\frac{1}{2}$ miles west of Balúmáth). Collect. Griesbach, 1878, and Feistmantel, 1881.

Nowadih, above the Karharbári beds of the same locality (see *ante*), Hutár coalfield. Collect. Feistmantel, 1883.

Saidope, outcrops north of, at the confluence of the Dauri and Ghorsum streams, in the Hutár coalfield. Collect. Feistmantel, 1883.—Fossils in black coaly shale.

Satgharia river, outcrops in, east of Bijka, north-western part of the Hutár coalfield. Collect. Feistmantel, 1883.

Sukri river, east, slightly north of Rájbar, at about the place where the road from Gurtur to Rájbar crosses the river; north-eastern part of the Auranga coalfield. Collect. Feistmantel, 1881.

Sukri river, $\frac{3}{4}$ mile west of Gurtur, also about $\frac{3}{4}$ mile south-east of Rájbar, north-eastern part of the Auranga coalfield, north-west of Serak; Lohárdagga. Collect. Feistmantel 1881.—Yielded very interesting fossils.

B.—Ironstone shales.

Jainagar, in the South-Káranpura coalfield, on the Naikori river, about 25 miles south of Hazáribágh, close by the road to Ranchi. Collect. Feistmantel, 1881.

C.—Raniganj group.

Burgaon, $2\frac{1}{2}$ miles west of, in Ganeshpúr river, below Nuwada village, Káranpura coalfield (Burgaon itself lies at the Sátphahri hill). Collect. Feistmantel, 1881.

Jaguldagga, inlyer $1\frac{1}{4}$ mile north of, in the Auranga coalfield. Collect. Feistmantel, 1881.

Tundwa, 3 miles south-east of; in the Garhi river, Káranpura coalfield. Collect. Feistmantel, 1881.

III.—TRANSITIONAL BEDS.—(Like Mákadevas.)

Latiahár hill, northern face of; close to the crest of the hill, in the Auranga coalfield. Collect. Ball, 1877, and Feistmantel, 1881.—Fossils of lower-Gondwána

type, in red shales, stratigraphically and petrographically of upper-Gondwána appearance.

DESCRIPTION OF THE FOSSILS.

The fossils to be described here are not very numerous, but still not without interest. As they come from deposits similar to others already described, it is only natural that many resemble those previously noticed and illustrated.

PLANTÆ.

A.—CRYPTOGAMÆ.

I.—PTERIDOPHYTA.

1.—EQUISETACEÆ.

Genus: SCHIZONEURA, *Schimp.* and *Moug.*, 1844.

Feistmantel: Gondwána Flora, Vol. III, Pt. 2, p. 59.

There is nothing to be added to the general remarks, as contained in my above work.

SCHIZONEURA GONDWANENSIS, *Fstn.*

1876. Feistmantel: Rec. Geol. Survey of India, Vol. IX, p. 69.

1880. Gondwána Flora, Vol. III, p. 61, and numerous figures.

1882. Flora of the South-Rewah Gondwána Basin; this Vol., Pt. 1, p. 21.

This species, the only one as yet found in India, has already been fully described and illustrated in previous memoirs. Its occurrence here is however of interest with regard to the geographical distribution of the species, again illustrating the fact that it is not limited to a constant horizon, as it occurs in the Barákar group and passes even into the upper-Gondwána; still it predominates in the Raniganj group; wherever it occurs in this group it is as a rule very numerous.

In the present coalfields it occurred rather numerously only in Ramkola and Tatapáni, where Mr. Griesbach collected several good specimens; here it fills the coal shale of the Raniganj group as numerously as it does in the Raniganj field; the specimens are in layers one over the other, preserved as leaved stalks of various sizes, and as single leaves.

Occurrence. a. Barákar group.—Sukri river (west of Gurtur), east-by-north of Rájbar, north-eastern portion of the field: only fragments of the leaf-sheath.

b. Raniganj group.—In the Garhi river, 3 miles south-east of Tandwa, Káran-pura coalfield: not very numerous. Also in the inlyer 1½ mile north of Jaguldagga, in the Auranga coalfield. Also in the Ramkola and Tatapáni coalfield.

c. *Transitional beds*.—Northern face of the Latiahar hill, Auranga coalfield. Only fragments, but there is no doubt about their belonging to this species, the commissural lines of the leaflets, as well as their middle veins being well seen.

If we now remember that this species also occurs in the Karharbári beds (Karharbári and Mohpáni coalfields) and in the Panchet group (Raniganj coalfield), then we have a distribution of it through almost the whole lower-Gondwánas; and in one locality we also find it in the Transitional beds (like Máhadévas).

Genus : TRIZYGIA, Royle, 1834.

1834-39. Royle: Botany and Nat. Hist. Him. Mts., p. 431.

TRIZYGIA SPECIOSA, Royle.

1880. Feistmantel: Gondwána Flora, Vol. III, p. 69 and figures.

Amongst the coalfields now under notice it was only in the Auranga coalfield that specimens of *Trizygia speciosa*, Royle, were collected; they do not however call for any further remarks upon the species, being identical with those known previously; the occurrence was however of interest to complete our knowledge of the geographical and stratigraphical distribution of the species; for we know it now from almost all the Damuda valley coalfields, from the Auranga field, from the South-Rewah and the Sátpura basins, and to the south it is known in the Talchir coalfield. As regards geological range, it is known from the Barákar and from the Raniganj groups.

There is no essential distinction between the Raniganj and Barákar forms; both show the characteristic "three paired" arrangement of the leaflets, the same distribution of veins, &c. Amongst the specimens originally collected from the Raniganj group of the Raniganj field and from the Barákar group of the Talchir coalfield, there appeared a certain difference in size; but later discoveries have shown that this forms no substantial distinction.

Occurrence: *Barákar group*: Auranga coalfield in the Sukri river, west of Murup. (Griesbach, 1878).

Genus : VERTEBRARIA, Royle, 1834.

1837-39. Royle: Botany and Nat. Hist. Him. Mts., p. XXIX *, Pl. II, figs. 1-7.

1880. Feistmantel: Gondwána Flora, Vol. III, p. 71, *et seq.*

VERTEBRARIA INDICA, Royle. Pl. IV A, figs. 4, 5, 7-11; Pl. V A, fig. 1; Pl. XIII A, fig. 8.

1880. Feistmantel: *l. c.*, p. 72 and figures.

This species was found in the various coalfields under consideration, under like circumstances as elsewhere; also the various forms were the same as previously

observed, without yielding any further characters for properly determining the true nature of this somewhat mysterious, though very abundant fossil. It occurred in several horizons, beginning with the Talchir up to the Transitional beds (like Māhadévas).

The mode of preservation in one locality deserves special notice, *viz.*, from the Barákars in the Sukri river west of Gurtur, Auranga coalfield. Here the harder substance of the plant is replaced by a brown-red mass (apparently hydrate of iron) while the softer tissue disappeared, whereby the cross-sections of the plant appear on the reddish grey rock as star-like markings with 6—8 points, while the longitudinal sections appear as three red longitudinal lines, connected at intervals by cross lines (see plate IV A, figs. 4, 5, 7-11). Others again show very well the rootlet-like nature (Pl. V A, fig. 1).

Occurrence : *Talchir group* : Behia Bargaon, 18 miles north-east of Anukpur, South-Rewah (Pl. XIII A, fig. 8).

Karharbári beds.—Outcrops at Singra, 5 miles north of Daltonganj, Daltonganj coalfield.

Barákar group.—Ghui river, 1 mile south-south-east from Jugra, near Ara-hura, and in the Bishanpúr river, $3\frac{1}{2}$ miles south-east of Bálumáth, both in the Káranpura coalfield. Outlier north of Balúnagar, at north-eastern corner of Auranga coalfield. Sukri river west of Murup; near Jaguldagga; Sukri river west of Gurtur and east-by-north of Rájbar (Pl. IV A, figs. 4, 5, 7—11; V A, fig. 1) in the Auranga coalfield. Satgarhi channel east of Bijka in the Hútár coalfield.

Raniganj group.—Garhi river, 3 miles south-east of Tandwa in the Káranpura coalfield. Ganespur river, west of Burgaon, the same coalfield. Inlier $1\frac{1}{4}$ mile north of Jaguldagga, Auranga coalfield.

Transitional beds.—Latiahár hill, Auranga coalfield. (Also from South-Rewah at Daigaon.)

2.—*FILICES.*

a—*CYATHEACEÆ.*

Genus : *CYATHEA*.

CYATHEA comp. *TCHIATCHEFI*, *Smalh.*

1880. Feistmantel : *Gondwána Flora*, Vol. III, p. 75.

I have in my above work referred several specimens from the Barákar group of the Talchir coalfield to this species, which was described from the Altai mountains; and I have there sufficiently discussed its relations.

At present I refer to the same species a fragment of a pinna that I collected in the outcrops in the Garhi river, 3 miles south-east of Tandwa in the Káranpura coalfield. The outcrops are in the Raniganj group.

b.—TÆNIOPTERIDEÆ.

Genus : *MACROTÆNIOPTERIS*, Schimp.

This genus is here represented by two species, both of which are of some interest, especially with regard to the geological horizon in which they occurred.

MACROTÆNIOPTERIS DANÆOIDES, *Royle*, sp. Pl. IVA, figs. 2, 3.

1880. Feistmantel: Gondwána Flora, Vol. III, p. 88, and figures.

There are a few fragments of a *Macrotæniopteris*, which from the characters of their venation have, I think, to be referred to the above species. The two figures now given would represent the top portion of the leaf.

Its occurrence in three geological horizons is rather interesting.

Barákar group : Sukri river, west of Gurtur, Auranga coalfield (the figured specimens); it occurs here in very light-grey shales with bluish and reddish tints, together with the next species and with some other more recent looking forms.

Ironstone shales : in the Naikori river, near Jainagar, South-Káranpura coal-field.

Raniganj group : Inlier 1½ mile north of Jaguldagga, Auranga coalfield.

MACROTÆNIOPTERIS FEDDENI, *Fstn.* Pl. IA, fig. 1.

1880. Feistmantel: Gondwána Flora, Vol. III, Pt. 2, p. 89, &c.

I have previously figured several specimens from the Kámthi (Kámpti) area (Kámthi-Raniganj group) and from the Raniganj group of the South-Rewah Gondwána basin. I now give a figure of a good sized specimen, although not complete. It measures nearly 10 inches in length and about 5 in breadth. But we can easily restore the specimen at the top to about 1½ inches more; while the lower portion would allow of much more addition if we suppose as probable that the base of the leaf was formed somewhat as in *Macrotæniopt. danæoides*, Royle, sp. It recalls very much certain species of *Macrotæniopteris* from the upper-Gondwána (Rájmáhál group); but the characters of the veins are different. In the Damuda and Panchet Flora (*l. c.*, p. 90) I have given the sequence of the various related forms of *Macrotæniopteris* with regard to the closeness of the veins, and there *Macrot. feddeni* appears last but one. The veins are very well represented in the present figure.

It has hitherto been known only from the Kámthi-Raniganj group; the present specimen comes from the Barákar group, so that, like *Macrot. danæoides*, it occurs throughout the Damuda series.

In India it does not occur together with upper-Gondwána plants; but it does so in further India, in the coalbearing series of Tong-King, whence it was identified by Mr. M. R. Zeiller¹ and described in a paper on fossil plants from those coalbear-

¹ Examen de la Flore fossile des Couches de Charbon du Tong-King: par M. R. Zeiller, Ingénieur des Mines, (Extr. des Annales des mines, livr de Septembre-Octobre 1882).

ing beds, in which upper-Gondwána and lower-Gondwána species occur together with European rhætic forms.

Occurrence : *Barákar group* : Sukri river, west of Gurtur, Auranga coalfield, Lohárdagga (Pl. IA, fig. 1).

c.—*DICTYOTENIOPTERIDEÆ.*

This is the most numerously represented family of ferns in the lower-Gondwánas, containing all the various species of *Glossopteris* which is so very numerously represented in the Damudas, and occurring also in the Talchir-Karharbári beds.

Genus : *GLOSSOPTERIS*, *Bgt.*

1828. Bronguiart : Hist. des vég. fossiles, p. 222.

1880. Gondwána Flora, Vol. III, Pt. 2, pp. 94 *et seq.*

A complete series of the species of this genus is given in my above work ; where I grouped the various leaves in several sections, especially according to the characters of the net-venation. I have also pointed to the interesting circumstance that the fructification appears in *three* different states, *viz.*, in longitudinal rows of *sori* (India), along the *veins* (Australia) and along the margin (India), which by analogy with living ferns would represent as many different genera, belonging even to quite different families. As however the fructification was not in all cases very certain, and as the fructification was not exhibited in all the various forms, I did not attempt any generic separation, but left all the leaves under the generic name of *Glossopteris*, indicating the mode of fructification ; with the respective species.

There is not much to be added to the various species as previously described, and I shall quote them chiefly with regard to their distribution, both geographical and stratigraphical.

a.—*Narrow-leaved forms.*

GLOSSOPTERIS ANGUSTIFOLIA, *Bgt.* Pl. VA, fig. 5.

1880. Feistmantel : *l. c.*, p. 105, &c., and figures.

It was in this species that the fructification appeared to me to be marginal (Pteris-like) ; some specimens from Raniganj at least seemed to exhibit this.

Occurrence : *Barákar group* : Sukri river, west of Gurtur, Auranga coalfield.

Ironstone shales : Naikori river near Jainagar, South-Káranpura coalfield.

Raniganj group : Ganepur river, west of Burgaon, Káranpura coalfield (Pl. VA, fig. 5).

GLOSSOPTERIS FORMOSA, *Fst*m.

1880. Feistmantel : Gondwána Flora, Vol. III, Pt. 2, p. 106 and fig.¹

In shape it resembles the former species, but the nets are much wider. It represents *Glossopt. retifera* amongst the species with wide nets, which will be mentioned hereafter. It was originally described from the Raniganj group of the Raniganj coalfield; later it was discovered in the Ramkola coalfield and in the South-Rewah basin; we now have another addition to its distribution.

Occurrence : Raniganj group : Garhi river, 3 miles south-east of Tandwa, Káranpura coalfield.

 β —Forms with narrow nets.

This group contains some of the most frequent species of *Glossopteris* and at the same time two of the species with fructification.

GLOSSOPTERIS COMMUNIS, *Fst*m. Pl. II A, figs. 1, 2, 1a, 2a; Pl. XI, figs. 6, 8; Pl. XII A, figs. 1, 5b, 6a.

1880. Feistmantel : Gondwána Flora, Vol. III, Pt. 2, p. 98 and fig.

This is the most generally distributed species of *Glossopteris*; on some specimens from the Nágpúr area a fructification was observed consisting of sori arranged in longitudinal rows. Amongst the numerous specimens from the present area no fructificating specimens were found, but some interesting facts regarding the distribution of the species were elicited: *viz.* I have identified it from the Talchirs, and also from the red shales belonging to the Transitional beds. I had already in my Talchir-Karharbári Flora (p. 18) mentioned one instance of a *Glossopteris* from the Talchirs, and later in my Damuda-Panchet Flora I quoted it as *Glossopt. communis*; but the specimen was not quite distinct, so that doubts might have been entertained about its nature, had anybody chosen to do so. But at present I figure several specimens (Pl. XI A, figs. 6, 8; XII A, figs. 1, 5b, 6a) about which there is no doubt whatever, that they belong to *Glossopt. communis*. Thus *Glossopteris* begins undoubtedly in the Talchirs and goes up into much higher beds.

Occurrence : Talchir group : North-west of Rikba in the Chano basin, Káranpura coalfield (Pl. XI A, figs. 6, 8; XII A, figs. 1, 5b, 6a).

Karharbári beds : Outcrops at Singra, 5 miles north of Daltonganj; and also south of Rájhera, Daltonganj coalfield.

Barákar group : Ghui river, 1 mile south-by-east of Jugra, near Aráhura Bishanpur river, $3\frac{1}{2}$ miles south-east of Bálumáth—both in the Káranpura coalfield. Outlier north of Bálunagar. Sukri river, west of Gurtur (Pl. II A, figs. 1, 2, 1a, 2a), and Sukri river west of Murup—these latter in the Auranga coalfield.

Ironstone shales : Naikori river, near Jainagar, South-Káranpura coalfield.

Raniganj group : Garhi river, 3 miles south-east of Tandwa ; also Ganespur river west of Burgaon, Káranpura coalfield. Inlier $1\frac{1}{4}$ mile north of Jaguldagga, Auranga coalfield.

Transitional beds (like MÁhadévas) : Latiahar hill, Auranga coalfield.

GLOSSOPTERIS COMMUNIS, *Fstn.* var. STENONEURA.

1880. Feistmantel : Gondwána Flora, Vol. III, Pt. 2, p. 99.

This species, originally brought from the Barákars of the Raniganj coalfield, was met with rather numerously at one locality, *viz.* in the—

Barákar group : in the Bishanpur river, $3\frac{1}{2}$ miles south-east of Bálumáth, Káranpura coalfield.

GLOSSOPTERIS INDICA, *Schimp.* Pl. XII A, figs. 2, 6b; Pl. XIV A, fig. 7.

1880. Feistmantel : Gondwána Flora, Vol. III, Pt. 2, p. 101.

In this species, which differs from the former by a somewhat different mode of net-venation, a similar fructification was observed, and again from the Nágpúr area. At present a similar distribution will be noticed as for *Glossopt. communis*.

Occurrence : *Talchir group* : North-west of Rikba Chano basin, Káranpura coalfield (Pl. XII A, figs. 2, 6b).

Karharbári beds : Outcrops south of Rájhera (Pl. XIV A, fig. 7) also outcrops at Singra, 5 miles north of Daltonganj, both in Daltonganj coalfield.

Barákar group : Ghui river, 1 mile south-by-east of Jugra, near Aráhura, also $3\frac{1}{2}$ miles south-east of Bálumáth (in the Bishanpur river), both in Káranpura coalfield. Sukri river, west of Gurtur, Auranga coalfield. Outcrops north of Saidope, at confluence of Dáuri and Ghorsum streams, Hútár coalfield.

Ironstone shales : Naikori river near Jainagar, in South-Káranpura coalfield.

Raniganj group : Garhi river, 3 miles south-east of Tandwa, Káranpura coalfield ; also Ganespur river, west of Burgaon in the same coalfield.

Transitional beds (like MÁhadévas) : Latiahar hill, Auranga coalfield.

γ—*Intermediate forms.*

To this group belongs one species only, that about which so much has been written with regard to the correlation of the Indian coalbearing rocks with those in Australia (N. S. Wales) some of which latter are of carboniferous age.

I shall however refrain from discussing the matter again. I only hope that all interested in the subject have by this time formed a correct opinion ; for the fact is unquestionable that *Glossopteris* and even *Gl. browniana* might have begun to live in Australia at an earlier epoch and might have survived into higher beds in India, the more so as the Indian and Australian leaves, which according to the net-venation appear both to be *Gl. browniana*, seem to differ in fructification.

• **GLOSSOPTERIS BROWNIANA.** Pl. IA, figs. 2, 2a.

•
1880. Feistmantel : *L. c.* p. 102 (esp. Pl. XXV, fig. 2; XXVII, fig. 2, in fructif.)

In quoting this species from the Indian Gondwāna system the identification can refer to sterile fronds only, their net-venation being like that of the Australian specimens of *Gl. browniana*. But as regards fructification the Indian *Glossopt. browniana* would appear to differ from the Australian form ; for (see the quoted figures) some Indian specimens, which with regard to net-venation have to be considered as *Glossopteris browniana*, show a fructification like *Gl. communis* and *Glossopt. indica* ; while according to Carruthers the Australian form would appear to show a fructification along the veins.

We would thus have not only a difference between *Glossopt. browniana* Bgt. var. *indica* (the present *Gl. indica*, Schimp.) and *Glossopt. browniana* Bgt. var. *australisica* (the typical *browniana*), but also a difference between certain Indian leaves (which with regard to the net-venation represent the real *browniana*) and Australian leaves of *Glossopt. browniana*, if the fructifying specimens are taken into consideration. From the present ground some sterile fronds from one locality are now noted.

Occurrence : Barákar group, Sukri river west of Gurtur, Auranga coalfield.

Glossopteris browniana, var. *australisica*, is also amongst the species described by Mr. Zeiller (*l.c.*) from the coalbearing series of Tong-King, where it occurs together with upper-Gondwāna plants and European rhaetic species ; while in Europe it is unknown in these beds, all the leaves which were previously quoted from rhaetic (as well as liassic) beds as *Glossopteris*, belonging to *Sagenopteris*, a genus with a simple frond quite different from the former.

8.—Broad-Netted Forms.

GLOSSOPTERIS DAMUDICA, *Fstn.* Pl. IA, fig. 3 ; IV A, fig. 1 (right figure) ;
VA, fig. 6.

1880. Feistmantel : *L. c.*, p. 105 and figures.

Of this nice species, which is so generally distributed through the various horizons of the Damudas, beginning in the Karharbári beds and passing into the Máladevas, I give at present three figures, one of which (Pl. IV A, fig. 1, right figure) completely coincides with the figure given in my Damuda-Panchet Flora (*l.c.*) Pl. XXX, figs. 1, 2, of a specimen from the Ironstone of Kulti, Raniganj coalfield, though the present specimen is from the Barákar group. But it proved also here a most widely distributed species.

Occurrence : Barákar group : Sukri river, west of Gurtur, and east slightly north of Rájbar, Auranga coalfield (Pl. IA, figs. 3, 3a, and Pl. IV A, fig. 1, right figure). Also north of Saidope at the junction of the Dauri and Ghorsum streams, Hútár coalfield.

Ironstone shales : Naikori river, near Jainagar, S. Káranpura coalfield (Pl. VA, fig. 6).

Raniganj group : Ganespur river, west of Burgaon, Káranpura coalfield.

Transitional beds (like MÁhadévas) : Latiahar hill, Auranga coalfield.

GLOSSOPTERIS RETIFERA, *Fstn.* Pl. IVA, fig. 1 (left figure).

1880. Feistmantel : *l. c.*, p. 103 and figs.

Hitherto this species was known from the Raniganj group only, and it almost appeared characteristic of the group, but I now quote it from several horizons. It presents in all the same characters as the original Raniganj species ; in one instance it occurred together with *Gl. damudica* on the same specimen of shale from the Barákar group.

Occurrence : *Barákar group* : Sukri river, east-by-north of Rájbar, Auranga coalfield (the figured specimen).

Ironstone shales : Naikori river, near Jainagar, South-Káranpura coalfield.

Raniganj group : Ganespur river, west of Burgaon, Káranpura coalfield.

GLOSSOPTERIS CONSPICUA, *Fstn.*

1880. Feistmantel : *l. c.*, p. 104, Pl. XXVIIIA, figs. 1, 5, 6, 8, 9.

This is a species with the largest net-venation. It occurred pretty frequently in the Raniganj group, Raniganj field, and several figures were given in my above work. In the present area it occurred in two horizons, and at one locality the leaves were not uncommon, resembling in form that figured *l. c.*, Pl. XXVIIIA, Fig. 1.

Occurrence : *Ironstone shales* : Naikori river, near Jainagar, South-Káranpura coalfield.

Raniganj group : Garhi river 3 miles south-east of Tandwa, Káranpura coal-field (from here the leaves, above referred to). Also, inlyer $1\frac{1}{4}$ mile north of Jagul-dagga, Auranga coalfield.

c.—*Incertæ*.

GLOSSOPTERIS DECIPIENS, *Fstn.*

1878. Feistmantel : Talchir-Karharbári Flora, Gondwána Flora, Vol. III. Pt. 1, p. 17, Pl. XXVIII, figs. 3-5.

One specimen, resembling those originally described from the Karharbári coal-field, occurred at one locality, similarly placed, *viz.* :

Karharbári beds : outcrops south of Rájhera, Daltonganj coalfield.

We have thus, with the above additions, the following facts about the distribution of the genus *Glossopteris* :

(a) *Glossopteris* was found to be as abundant here as elsewhere.

(b) The existence of *Glossopteris* (apparently two species) in the Talchir group is proved beyond any doubt ; but it is scarce, while *Gangamopteris* predominates.

- (c) In the Karharbári beds it becomes more frequent, while *Gangamopteris* also is largely represented.
- (d) *Glossopteris* attains its chief development in the *Damuda* division, in all three groups equally; while *Gangamopteris* is quite a stranger.
- (e) *Glossopteris* however passes into beds of apparently much higher position (*Transitional beds*).

d.—DICTYOPTERIDEÆ.

This order, which in Europe comprises forms mostly with compound leaves and a compound net-venation, is represented in India by leaves with a simple net-venation, and apparently with simple fronds also. We have (besides some uncertain plants) two genera, *viz.* *Belemnopteris* (hitherto only known from the Raniganj coalfield) and *Gangamopteris*, largely represented in the Talchir group and Karharbári beds.

At present species of this latter genus only will be described.

Genus : **GANGAMOPTERIS**, McCoy.

1875. McCoy : *Prodrom. of the Palæontol. of Victoria*. Decade I, p. 11.

This genus was first described from the Bacchus-Marsh sandstones of Victoria, and three species were distinguished by Prof. McCoy. Soon afterwards I identified the same genus from the Talchir group and Karharbári beds in India; and I consider it characteristic of these two groups of the Talchir division.

Hitherto this genus is known from India and Australia only.

In the present memoir I have figured a good number of instructive specimens from both groups, which well illustrate the great variety of forms belonging to this

RIS CYCLOPTEROIDES, *Fstn.* Pl. VI A, figs. 1, 2; Pl. VIII A, fig. 6; IX A, fig. 2; XII A, fig. 17; XIII A, fig. 1; XIV A, figs. 1—4.

1879. Feistmantel : *Gondwána Flora*, Vol. III, Pt. 1, p. 12, &c.

This is the original Talchir form, subsequently recognised among the Karharbári fossils, and of which I distinguished several varieties. In none of the very numerous specimens has any indication of fructification been as yet observed, so that it is not quite easy to form a correct idea of the true systematical position. Nor can we form an idea of the mode of growing or living, as nothing has been found that might represent the rhizome or base of attachment of the leaves. I would feel inclined to think that the leaves of this species, as well as of its varieties were attached to a creeping or climbing rhizome.

Occurrence : *Talchir group* : North-west of Rikba, Chano basin, Káranpura coalfield (Pl. VI A, figs. 1, 2; VIII A, fig. 6; IX A, fig. 2); Eátiahar hill, Auranga

coalfield (XIIA, fig. 17; XIII A, fig. 1); stream south of village Nowadih, Hutár coalfield.

Karharbári beds: Outcrops south of Rájhera, Daltonganj coalfield (Pl. XIV A, figs. 1—4); south of village Nowadih, Hutár coalfield.

Varieties of Gangamopteris cyclopterooides.

These are much more numerous than the type form itself; they have a more elongated leaf, with a variously formed base, slightly auricled, cordiform, attenuate, the top acuminate, and so on. But they all have to be classed as *Gangamopteris*, there being no solid midrib from which the secondary veins pass out; it is replaced by a number of stronger veins but always forming anastomoses and resolved by repeated dichotomy into the secondary veins which then form the lateral net-work of the leaf.

Many leaves now figured exhibited a rather interesting character, i.e., the margin appeared frequently doubled up, whereby the venation of the folded portions, overlying each other, produce a peculiar reticulation. In many cases it so happened that the upper overlying portion of the leaf got removed and that thus only the impression of the venation remained, causing an appearance as of cross-reticulated venation.

This peculiarity is especially well shown in two specimens (Pl. X A, figs. 2, 4); the marginal portions of the leaf are quite regularly turned over, so far that they meet in the middle line of the leaf, in consequence of which it appears as if there were a midrib and a lateral reticulated venation. But if we consider at first the specimen, figured Pl. X A, fig. 2, we can in the lower part clearly see the radiary ascending veins, then we can very well make out the overturned margin of the leaf by which the venation of the underlying and overlying portions cross each other producing the above mentioned reticulation.

The other specimens figured on the same plate show also the peculiarity of the folded margin, and in such a manner as to explain, by gradation, the way in which at last the two specimens (figs. 2, 4) came to be as they are figured.

It is very easy to imitate this state of the leaves by drawing on transparent paper an oblong leaf with a venation radiating from the base towards the margin; and then turning the margins over until they meet in the middle line, resulting in forms like those on Pl. X A, figs. 2, 4.

GANGAMOPT. CYCLOPTEROIDES, var SUBAURICULATA. Pl. V A, fig. 10; VI A, figs. 3, 4; VII A, figs. 1—3, 6; VIII A, figs. 2, 3; IX A, figs. 1, 3, 4, b, c; X A, figs. 1—7; XIII A, figs. 3, 7; XIV A, fig. 5.

1879. Feistmantel : *l. c.*, p. 13, and figs.

This is one of the most numerous varieties; it resembles most of all the original form; the leaf is however elongate, slightly cut out at the base, and the basal angles slightly auricled. The specimens with doubled up margin belong to this

species. Two very typical specimens, though of small size, are figured on Pl. VIIA, fig. 2, and Pl. XA, fig. 3. I think both convey well the idea of their having been attached by the leaf-base to a rhizoma, as already mentioned.

Another specimen, figured Pl. IX, fig. 1, I think also belongs to this variety; it is marked by a very strong venation and by very distinct meshes.

Occurrence: *Talchir group*: North-west of Rikba, Chano basin, Káranpura coalfield (Pl. VA, fig. 10; VIA, figs. 3, 4; VIIA, figs. 1—3, 6; VIII A, fig. 2; IXA, figs. 1, 3, 4, b, c; XA, figs. 1, 2, 4—7). Látiahar hill, Auranga coalfield (Pl. XA, fig. 3; XIII A, figs. 3, 7). Stream south of village Nowadih, Hutár coalfield.

Karharbári beds: Outerops south of Rájhera, Daltonganj coalfield (Pl. XIV A, fig. 5).

GANGAMOPTERIS CYCLOPTER. var. ATTENUATA. Pl. VIIA, fig. 1; IXA, fig. 4 a; XIII A, figs. 4, 6; XIV A, fig. 6.

1879. Fristmantel: *t. c.*, p. 14, and fig.

The leaves of this species are considerably narrowed at the base.

Occurrence: *Talchir group*: North-west of Rikba, Chano basin, Káranpura coalfield (VIIA, fig. 1; IXA, fig. 4a); Látiahar hill, Auranga coalfield (XIII A, figs. 4, 6).

Karharbári beds: Outerops at Singra, Daltonganj coalfield. Also outerops south of Rájhera, Daltonganj coalfield (Pl. XIV A, fig. 6). South of village Nowadih, Hutár coalfield.

GANGAM. CYCLOPTER. var. ACUMINATA. Pl. VIIA, fig. 4 (?), 5; VIII A, fig. 5; XI A, figs. 4, 7.

While most of the leaves hitherto observed had an obtuse apex, there were amongst the fossils now under consideration several leaves of *Gang. cyclopterooides* with a distinctly prolonged and pointed apical portion, so that I thought it necessary to draw attention to them by distinguishing them as a variety. Otherwise they appear close to var. *subauriculata*.

Occurrence: *Talchir group*: North-west of Rikba, Chano basin, Káranpura coalfield (the above figures) and Látiahar hill, Auranga coalfield.

GANGAMOPTERIS CYCLOPT. var. CORDIFOLIA. Pl. XI A, figs. 1, 3; XII A, figs. 16, 18; XIII A, fig. 2.

Several small leaflets are distinguished by their cordiform shape, with straight distinctly radiating but anastomosing veins. They appear very much as if they belonged to a pinnate leaf; I refer especially to fig. 2, Pl. XIII A. It may however be, that they are only small undeveloped specimens of *Gangam. cyclopterooides*, and then their attachment would be similar, *i.e.*, to a creeping rhizome.

Occurrence : *Talchir group* : North-west of Rikba, Chano basin, Káranpura coalfield (Pl. XI A, figs. 1, 3).

Latiahar Hill, Auranga coalfield (Pl. XII A, figs. 16, 18; XIII A, fig. 2).

GANGAMOPTERIS comp. OBLIQUA, McCoy. Pl. XI A, figs. 2, 5.

1875. McCoy : *Prodrome Palaeontol. Victoria*, Decade II, p. 13, Pl. XII, figs. 2-4.

I have previously pointed out that the Indian *Gangamopt. cyclopterooides* from its form and from the great number and the variety of its leaves most resembles the Victorian *Gangamopt. obliqua*. But there is in the present collection one specimen, which from the shape of the leaf and the distribution of the veins has most probably to be referred to this species.

Occurrence : *Talchir group* : North-west of Rikba, Chano basin, Káranpura coalfield (the figured specimen).

GANGAMOPTERIS ANGUSTIFOLIA, McCoy.

1875. McCoy : *Prod. Pal. Victoria*, Dec. II, p. 11, Pl. XII, fig. 1; XIII, fig. 2.

1879. Talchir-Karharbári Flora : *Gondwána Flora*, Vol. III, Pt. 1, p. 16, Pl. IX, fig. 5.

This species has already been described and illustrated ; it was known from the Talchir shales of the Karaun field and from the Karharbári beds, Karharbári coalfield. I have now identified it again, and one specimen resembles very much the figure given by McCoy (*l. c.*).

Occurrence : *Talchir group* : North-west of Rikba, Chano basin, Káranpura coalfield.

GANGAMOPTERIS comp. BURIADICA, Fstn. Pl. VIII A, fig. 7.

1879. Feistmantel : *Gondwána Flora*, Vol. III, Pt. 1, p. 15, Pl. XVIII, figs. 1, 2.

There are several specimens from the Talchir shales which from the shape of the leaf and the disposition of the veins have most probably to be referred to this species of the Karharbári beds. There is nothing strange in this, as Talchir shales and Karharbári beds belong to the same division, many of their species being identical.

Occurrence : *Talchir group* : North-west of Rikba, Chano basin, Káranpura coalfield.

GANGAMOPTERIS MAJOR, Fstn. Pl. VA, fig. 9; XI A, fig. 9.

1879. Feistmantel : *l. c.*, p. 15, and fig.

I originally compared this species with McCoy's *Gangamopteris spathulata*,¹ but the leaves appeared somewhat larger, more regular, and the veins more straightly

• • • McCoy, *l. c.*, p. 12, Pl. XIII, figs. 1, 1a.

radiating. It was first described from the Karharbári beds, Karharbári coal-field ; at present I have identified it from the Talchir shales also.

Occurrence : Talchir-shales : North-west of Rikba, Chano basin, Káranpura coalfield (the figured specimens).

Several other leaflets, which according to their radiating net-venation without midrib have to be considered as belonging to the genus *Gangamopteris*, occurred at several other places, but it is not well practicable to describe them as separate species, as the material is rather scanty. I have figured some of them ; they are from the following localities :

Barákar group : Sukri river, west of Gurtur, Auranga coalfield (Pl. II A, figs. 3, 3a).

Ironstone shales : Naikori river, near Jainagar, South-Káranpura coalfield (Pl. V A, fig. 7).

Transitional beds (Máhadévas), Latiahar hill (northern face), Auranga coal-field.

There is another specimen figured on Pl. V A, fig. 4, which however is apparently only a fragment ; but there is a distinct net-venation, consisting of oblong polygonal meshes. At first it might appear to be only a fragment of a *Glossopteris* leaf ; but a closer examination shows, that the general direction of the net-venation is radiating, viz., diverging from below to the top and the meshes becoming smaller in that direction. These circumstances place the specimen amongst the leaves belonging to the genus *Gangamopteris* ; at the same time it has a great resemblance to *Anthrophyum*, so that I would propose to place it with *Gangamopteris anthrophyoides*, a species that I described originally from the Raniganj group of the Raniganj coalfield. The present specimen represents however a somewhat larger form.

Occurrence : Raniganj group : Ganespur river west of Burgaon, Káranpura coalfield (the figured specimen).

There is one more fossil, which has been previously described, but which is of rather uncertain systematical position. The specimen is figured in fig. 3, Pl. V A, and it is identical with those figured in my Damuda-Panchet Flora,¹ Pl. XXIIIA, figs. 4-6, 14, which I named *Dictyopteridium*, and which came from the Barákar and Raniganj groups. At present I quote this fossil from one locality.

Occurrence : Raniganj group : Garhi river, 3 miles south-east of Tandwa, Káranpura coalfield.

B.—GYMNOSPERMÆ.

I.—CYCADEACEÆ.

From the present ground we have not many remains of *Cycadeaceæ*, still there are some of no small interest.

¹ Gondwāna Flora, Vol. III, Pt. 2.

Recently the *Cycadeaceæ* have been newly subdivided, and several forms that were formerly considered as *Cycadeaceæ* have been eliminated and placed partly with the ferns, partly with the *Coniferæ*; this applies especially to the family *Nöggerathieæ*, as I shall notice again when discussing *Nöggerathiopsis* (=*Rhiptozamites*).

a.—Living Cycadeaceæ.

With regard to the living forms, the *Cycadeaceæ* are subdivided as follows :—

1. *Cycadeæ* including the genus *Cycas*, Lin.
2. *Encephalartoeæ* including the genera: *Encephalartos*, Lehm.; *Macrozamia*, Miq.; *Dioon*, Lindl.; *Bowenia*, Hook.
3. *Stangerieæ* with genus *Stangeria*.
4. *Zamieæ* including: *Zamia*; *Microcycas*, Miq.; *Ceratozamia*, Bgt.

b.—Fossil Cycadeaceæ.

The fossil forms of *Cycadeaceæ* are much more various than the living ones. There are many known from India, and at present I have to describe a new form. It will be useful to give at first a view of the various genera according to the recent classification, together with an indication as to which of them occur in India, and where.

1.—*Cycadeæ.*

Genus: *Cycadites*, Bgt. Several species in the upper-Gondwána in India. In Europe it begins in the carboniferous formation.

2.—*Encephalartoeæ.*

Genus: *Encephalartos*, Lehm. Tertiary in Europe.

3.—*Zamieæ.*

Genus: *Podozamites*, Fr. Braun. Upper-Gondwána (Sripermatur and Jabalpur groups) in India. Begins in Europe in the rhætic formation.

Genus: *Zamites*, Bgt. One species in the Rajmahál group of India. Otherwise in Europe in various formations, beginning with lower trias (Bunter).

Genus: *Glossozamites*, Schimper. One species in the Karharbári beds (Talchir division), lower-Gondwána in India. In Europe a few species in the cretaceous formation.

Genus: *Otozamites*, Fr. Braun. Several species from all groups of the upper-Gondwána in India. In Europe they are distributed through the jurassic formation.

Genus: *Ptilophyllum*, Morr. Hitherto known from India only—from all groups of the upper-Gondwána.

Genus : *Ctenophyllum*, Schimp. Jurassic formation in Europe.

Genus : *Dioonites*, Bornem. In Europe from rhætic up to cretaceous.

Genus : *Pterophyllum*, Bgt. Several species from the upper-Gondwána (Rajmahál, Sripermatur and Jabalpur groups) and one species from the lower-Gondwána (Raniganj group) in India. I have placed here all those forms with equal leaflets, while I placed the others with the next genus; but Schimper thought that even some of these species of *Pterophyllum* would allow of being placed in a separate genus, of which, however, I do not see any necessity.

In Europe the genus begins in the carboniferous formation and goes up into Wealden.

Genus : *Anomozamites*, Schimp. This includes *Pterophyllum*-like leaves with unequal segments. In Europe it is rhætic, jurassic and cretaceous. Of Indian species I have placed with it several forms from the Rajmahál and Sripermatur groups of the upper-Gondwána.

It has however still to be subdivided, as I shall show further on, when describing the new form of Pterophylloid plant.

Genus : *Ptilozamites*, Nath. In Europe in rhætic strata of Sweden.

Genus : *Nilsonia*, Bgt. In rhætic and jurassic strata of Europe.

Genus : *Sphenozamites*, Bgt. Jurassic strata of Europe.

Genus : *Macropterygium*, Schimp. Keuper of Europe.

Besides these, there are remains of inflorescences, fruit cones, fruit leaves, seeds and stems, which all bear separate names.

We have now to describe our new fossil. It belongs to the—

1.—*Zamiceæ*.

This fossil is not only interesting from the fact of being a new form, but especially through the circumstance that it comes from beds belonging to the lower-Gondwána, while it belongs to a section largely represented in the upper-Gondwána. It belongs to the *Pterophyllum*-like plants, but to that section which Schimper in his Trait. d. Paléont. végét. placed with *Anomozamites*. More recently however the same author has still further defined the genus *Anomozamites*, from which it follows that only a few of our Indian *Pterophyllum*-like plants are to be classed with *Anomozamites*, while the others are to be placed in a new subgenus : *Platyperigium*, Schimp. The matter stands thus :

Genus : *Anomozamites*, Schimp. Small leaves, sometimes entire, mostly however divided into unequal oblong segments. Veins pass out at right angles; they are simple and parallel.

In this genus would have to be placed of our Indian species the following : *Anomozamites fissus*, Fstm., from the Rajmahál group, Rajmahál hills, and from the Vemáveram shales (Sripermatur group), South-Kistna district.

Anomozamites jungens, Fstm., Vemáveram shales, and *Anomozam. lindleyanus*, Schimp., from the same group.

Subgenus : *Platypterygium*, Schimp. Leaves large, sometimes very large; rather thin; divided into unequal rounded or obtuse segments. Veins parallel, simple and forked.

In this section are to be placed especially the Indian *Anomozamites* (= *Platypterygium*) *princeps*, Oldh. and Morr. sp. from the Rajmahál group, Rajmahál hills; and *Anomozamites* (= *Platypterygium*) *morrisonianum*, Oldh. sp.

The new fossil has I think to be placed with this subgenus.

Genus : ANOMOZAMITES, Schimp.

Subgenus : PLATYPTERYGIUM, Schimp.

Diagnosis as above. The several specimens are figured on Pl. II A (figs. 4-8) and Pl. III A, fig. 2 (right figure). There seems no doubt that these leaves can best be placed with this subgenus. They appear to be of good size; the leaf itself is rather thin, and divided into unequal segments, in which the veins are several times forked.

All the specimens belong to one species:

PLATYPTERYGIUM BALLI, *Fstn.* Pl. II A, figs. 4-8; Pl. III A, fig. 2.

1881. *Anomozamites balli*, Feistmantel : R. G. S. I., Vol. XIV, Pt. 3, p. 256.

Fronde mediocri magnitudine, elongato-obovata, in pinnas inaequales divisa; pinnis ex rhachide striatula prope sub angulo recto eggredientibus, apice truncato obovatis, basim versus connatis. Nervis 4-8, e basi crassiusculis simplicibus an plurime dichotomis, dehinc teneribus, adhuc semel an bis furcatis.

We have here a form, the leaf of which was middle-sized, in shape oblong-ovate, as can be judged from the shape of the lower portion (Pl. II A, fig. 7) and of the upper portions (Pl. II A, figs. 5, 8). It is divided into leaflets of unequal size, as is best illustrated by figs. 5 and 8, Pl. II A; they leave the wrinkled rhachis almost at right angles; their apex is truncately ovate, and at the base they are connected, although close to it they are slightly contracted. According to the breadth of the leaflets, the veins number 4-8; they are thicker at the base, where they mostly bifurcate immediately, and again once or twice in their course through the leaflet. At the apex the leaf ends with a pair of small leaflets, as is shown by the figs. 4, 5 and 8, Pl. II A, and fig. 2 (right figure), Pl. III A.

Occurrence.—These specimens are especially interesting on account of their occurrence in the Barákar group; in the Sukri river, west of Gurtur, Auranga coalfield, from the same locality as the fine specimen of *Macrotæniopteris feddenii*.

One species of *Pterophyllum* (*Pt. burdwanense*) has already been described from the Raniganj group, and here we have a *Platypterygium* from the Barakar group.

2. NÖGGERATHIOPSIÆ (1879).

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1879. Gondwána Flora, Vol. III, Pt. I, p. 20, &c., also p. 55 of Suppl.
1881. Damuda-Panchet Flora, *ibid.*, Pt. 2, p. 118, &c.

I have hitherto in my writings quoted this section of fossils as the last family of the *Cycadeaceæ*. I created it to include certain leaves that were formerly classed with *Nöggerathia*, but which I subsequently for good reasons placed in a new genus, *Nöggerathiopsis*, bringing into close relation with it the genus *Rhiptozamites* described first from the Russian jurassic by Schmalhausen. Schmalhausen himself considered *Rhiptozamites* to represent leaves of true cycadeaceous nature and to be leaflets of a pinnate leaf closely allied to the mesozoic *Podozamites*.

In the supplement to my Talchir and Karharbári Flora,¹ page 56, I wrote as follows :—

“If we now compare the diagnosis and the figures of *Rhiptozamites* with those of the Indian and Australian *Nöggerathiopsis*, we find that they are in very close relation and if not to the same genus, certainly belong to the same family.”

“The only difference appears in the number of the veins, but the circumstance that Prof. Göppert distinguished two species, a *N. aequalis* and a *N. distans*, clearly shows that also amongst these Siberian forms there seems to be some variation as regards the closeness of the veins; and as Prof. Schmalhausen amalgamates both these species of *Nöggerathia* into one species of his new genus *Rhiptozamites*, the somewhat greater distance of the veins in *Nöggerathiopsis* might eventually form only a specific difference.”

And again in my Damuda-Panchet Flora,² page 118, I pointed to their close relation and with regard to their being classed with the *Zamieæ*, which then seemed justified, I wrote :

“Should it, however, happen that the discovery of better and more complete specimens would make another arrangement necessary, it will be easy to transfer the whole family into another class to which it may appear to belong more properly.”

The name *Nöggerathiopsis* was proposed by myself in 1878 when the manuscript for my Talchir-Karharbári Flora was ready; but this was not published until early in 1879. In the same year (1879) Prof. Schmalhausen proposed his name *Rhiptozamites* in his “Beiträge zur Jurafloren Russlands,” which was published in November 1879, a short note having already appeared early in 1879.

I now see that Mr. Schmalhausen³ declares his *Rhiptozamites* and my *Nöggerathiopsis* to be identical; a view I had already expressed, as stated above.

But while Prof. Schmalhausen was in 1879 entirely convinced of the cycadeaceous nature of his leaves, calling them at once *Rhiptozamites*, he is now more inclined to consider his genus *Rhiptozamites* belonging rather to the *Cordaitea* (between

¹ Gondwána Flora, Vol. III, Pt. 1, Suppl. 1881.

² *Ibid.*, Pt. 2, 1881.

³ Pflanzenpaläontologische Beiträge: Mélang. biol., tom. XI, 1883.

Cycadaceæ and *Coniferæ*) than to the *Cycadeaceæ*, so that, both the genera being identical, our *Nöggerathiopsis* would have to be classed in the same way.

But Prof. Schmalhausen's reasons are not very conclusive; he simply states that there are no certain characters according to which these spathulate leaves, traversed by numerous closely set veins, which are equally thick and repeatedly forked, would have to be considered as leaflets of a pinnate leaf; that on the contrary there are transverse connections between the longitudinal veins and that they resemble some leaves of *Cordaites*. But even for this eventuality I was well prepared, as is evident from the passage quoted from my Damuda-Panchet Flora, page 118 (see above). Whether or not Prof. Schmalhausen is correct in placing these leaves with the *Cordaiteæ*, or whether they should rather be included in a separate family, cannot be decided conclusively from the existing materials.

But another question remains: which of the two names, *Rhiptozamites* or *Nöggerathiopsis*, should be retained in case such a transfer from the *Cycadaceæ* to the *Cordaiteæ* should be effected? I think *Nöggerathiopsis* is perhaps the better and more suitable name. As regards the priority of the names, it is really difficult to assign it to one or the other. Both names appear to have been given simultaneously, but independently; and while Mr. Schmalhausen's short note on the subject appeared in January 1879, my work on the Talchir-Karharbâri Flora, where the family *Nöggerathiopsidae* is discussed and illustrated was in press, and appeared several months before Schmalhausen's work with plates; so that the priority of one or the other is indefinite.

Otherwise, on its merits, *Nöggerathiopsis* appears to be the better name. Both the Indian and the Russian leaves (from the Altai) were formerly called *Nöggerathia*. Recognising that they do not belong to *Nöggerathia*, I called the Indian leaves *Nöggerathiopsis*, which thus reminds one of the previous name, while at the same time it is quite a general name, not having reference to any family.

Prof. Schmalhausen however, being then convinced of the cycadaceous nature of his leaves, called them *Rhiptozamites*, a name, which is in no connection with the previous name, but which is a very closely defined name, indicating at once not only the class (*Cycadeaceæ*) but also the family (*Zamiæ*) in which the genus was intended to be placed. If now, as Prof. Schmalhausen thinks, these leaves should be eliminated from the *Cycadeaceæ* and should be rather placed with the *Cordaiteæ* then it would at once follow, that *Rhiptozamites* would rather be a misplaced name in that family, which probably is more closely allied with the *Coniferæ*; while the name *Nöggerathiopsis* not only does not refer to a special family, but would moreover remind us of the fact that the old genus *Nöggerathia* was originally also classed in the same family (*Nöggerathicæ*) with *Cordaites*, while later it was shown that *Nöggerathia* contained very various plants. Thus we shall retain our name *Nöggerathiopsis*.

As the reasons for placing *Nöggerathiopsis* with the *Cordaiteæ* are not at all sufficiently established, I still consider it to form a separate section of plants, which

eventually may represent in Asia and Australia the *Cordaiteæ* of Europe and America. So long as the real attachment of the leaves (and leaflets), the inflorescence and the fructification, are not known, it is as correct to place the *Nöggerathiopsisæ* with the *Cycadeaceæ* as with the *Cordaiteæ*.

Genus : NÖGGERATHIOPSIS, *Fstn.*

1879. Feistmantel : *Talchir-Karharbári Flora* : Gondwána Flora, Vol. III, Pt. 1, p. 20 *et seq.*, also Suppl. to same, p. 55 *et seq.*
 1879. Palaeoz. und mesoz. Flora d. östl. Australien : *Palaontographica*, Cassel, 1879, p. 155, *et seq.*
 1879. Comp. Rhiphozamites, Schmalhausen : *Beiträge zur Jurafloren Russlands*.

There is nothing to be added to the characteristic of the genus. Only one species has to be noticed.

NÖGGERATHIOPSIS HISLOPI, *Fstn.* Pl. XIIA, fig. 5a ; XIII A, fig. 5.

Literature same as above.

This species has been already sufficiently discussed and illustrated ; I now quote it from several new localities, thus illustrating further its wide distribution in India. Unfortunately none of the specimens throw any new light upon the systematical relations of this peculiar species, which has its close representatives in the Russian jurassics (Altai, &c.), in the Australian lower and upper coalbeds, and which has recently been identified from the mesozoic coalbearing series of Tong-King (see Zeiller, *l. c.*)

Occurrence : *Talchir group* : North-west of Rikba, Chano basin, Káranpura coalfield (Pl. XIIA, fig. 5a). Also northern face of Latiahar hill, Auranga coal-field (Pl. XIII A, fig. 5).

Karhárbari beds : Outcrops at Singra, 5 miles north of Daltonganj, Dalton-ganj coalfield.

Bárákar group : Bishanpur river, 3½ miles south-east of Bálumáth, Káran-pura coalfield.

Ironstone shales : Naikori river near Jainagar, S. Káranpura coalfield.

In South-Rewah it was found in the Transitional beds of Parsora.

II.-

From the Gondwánas in India a considerable number of coniferous remains have been described, for a general view of them I refer to my paper entitled "A sketch of the history of the fossils of the Indian Gondwána system."¹ There are several interesting forms amongst them. I have now to describe and illustrate two other forms, which appear of further interest.

Since my last publication on this subject several new arrangements regarding the systematical division of the *Coniferæ* have been proposed, so it will be useful to give here an outline of the system of this class of plants.

¹ Asiatic Society of Bengal, Journal, Vol. L., Pt. 2, 1881.

1.—*Taxaceæ.*

To this order belong especially those forms with broad leaves, represented in the living flora by *Gingko* (*Salisburia*), which eventually may form a separate family *Salisburicæ*, an arrangement which I adopted in my previous works on fossil botany. The most important genera are :—

Ginkophyllum, Saporta : Carboniferous and permian in Europe.

Baiera, F. Braun : permian to cretaceous in Europe and America.

Gingko, Lin. : living, in Japan and China; fossil, from permian through all formations. In India two species are known from the upper-Gondwáñas (Sripermatúr and Jabalpur groups).

Rhipidopsis, Schmalh. : jurassic of Russia (Siberia). In India two species are known from the Damuda division.

Dicranophyllum, Grand Eury : carboniferous and permian in Europe, America and China.

Trichopitys, Saporta : permian and jurassic in Europe.

Czekanowskia, Heer : rhætic, jurassic and cretaceous in Europe, Siberia and China. In India in the Jabalpur group.

Feildenia, Heer : tertiary in the arctic region.

Phænicopsis, Heer : jurassic of Europe and north-east Siberia. In India in the Jabalpur group.

Euryphyllum, Fstm. : Karharbári beds in India.

Taxites, Bgt. : upper-Gondwáñas, India.

2.—*Walchiaæ.*

Walchia, Sternberg : Carboniferous and permian. *Ullmannia*, Göppert : permian. *Pagiophyllum*, Heer (= *Pachiphyllum*, Saporta) : jurassic up to tertiary. This latter genus in India, in the upper-Gondwáñas.

3.—*Araucarieæ.*

Dammara, Lamb. (Dammarites) : living ; fossil, not quite certainly known, though several species are described from cretaceous rocks.

Araucaria, Jussieu (Araucarites, Stbg.) : living ; fossil, it begins in jurassic times. In India it is known from the upper-Gondwáñas.

Cunninghamites, Stbg. : living (Cunninghamia) ; fossil, in cretaceous and tertiary formations.

Albertia, Schimp. and Moug. : lower trias (Bunter) in Europe. In India from the Karharbári beds.

4.—*Taxodineæ.*

Voltzia, Bgt. : begins in permian and goes up to middle keuper (upper trias). In India in the lower-Gondwáñas (Karharbári beds and Damudas).

Leptostrobus, Heer : jurassic.

Cyclopitys, Schmalhausen : jurassic in Russia (Siberia). Some plant remains from the Barákar group in India appear to belong here (to be described).

Taxodium, Rich. : living and tertiary.

Glyptostrobus, Endl. : cretaceous and tertiary.

Sequoia, Torrey : living ; fossil, in cretaceous and tertiary rocks.

Brachiphyllum, Brongn. : rhaetic, jurassic and wealden. In India it occurs in the upper-Gondwána.

Echinostrobus, Schimp. : jurassic in Europe. Upper-Gondwána in India.

Sphenolepidium, Heer : rhaetic up to Wealden.

Inolepis, Heer : cretaceous of Greenland.

Schizolepis, Fr. Braun : permian up to jurassic.

Cheirolepis, Schimp. : rhaetic and liassic. Upper-Gondwána in India.

Swedenborgia, Nath. : rhaetic.

5.—*Cupressineæ*.

None of the Indian fossil coniferous plants belong to this family. The chief genera are : *Widdringtonites*, Endl.; *Widdringtonia*, Endl.; *Callitris*, Venten. ; *Frenelopsis*, Schenk ; *Libocedrus*, Endl. ; *Moriconia*, Deb. and Ettingh. ; *Thuyites*, Brongn. ; *Thuya*, Lin. ; *Biota*, Endl. ; *Chamaecyparis*, Spach. ; *Cupressus*, Lin. ; *Palaeocyparis*, Sap. ; *Phyllostrobus*, Sap. ; *Juniperus*, Lin.

6.—*Abietineæ*.

This family includes well known genera, as *Pinus*, *Abies*, *Picea*, *Cedrus*, *Larix*, &c. Of fossil genera, *Palissya* Endl. may be especially mentioned ; it is represented in the upper-Gondwána, by two or three species.

1.—TAXACEÆ.

I have to introduce here one species of the Gingko-like coniferous plants.

Genus : RHIPIDOPSIS, Schmalh.

1879. Beiträge zur Jurafloren Russlands : 'Mém. de l'Acad. Imp. d. Sc. de St. Petersbourg, VII Serie, Tome XXVII, No. 4, pp. 50, &c.'

This genus was first established by Schmalhausen (*l. c.*) to include certain leaves from the jurassies of the Petschora country. Only one species *Rh. gingkoides* was then described. Later I placed with the same genus certain leaves from the Damudas of Southern India, which however differed in the closeness of their veins and I therefore called the Indian species *Rhipid. densinervis*.¹

At present I have to describe some leaves which do not appear to differ from the Russian species, except in their smaller size ; this cannot however be taken as an

¹ Damuda-Panchot Flora : Gondwána Flora, Vol. III, Pt. 2, p. 121.

important distinguishing character and I shall have to describe our leaves as identical with the Russian species.

RHIPIDOPSIS GINKHOIDES, Schmalh. Pl. IIIA, figs. 1, 2.

1879. Schmalhausen : *l. c.*, pp. 50 et seq.

Folia stipitata, subcoriacea, flabelliformia, pinnatisecta, segmentis 6-10, integrimis, lateralibus minoribus e basi cuneiformi obovatis, mediis majoribus, basi substipitatis, cuneiformibus, antice obtusis; nervis numerosis e basi crassiusculis, dehinc plures dichotomis.

Only two specimens of this very interesting plant have hitherto been found in India. The specimens consist of leaves and a stalk, or stem-like impression, which I think belongs to the plant and upon which the leaves might have been inserted in bunches. The leaves of our specimens are on the whole smaller than those in the Russian plant, but one leaf from the Petschora country is figured by Mr. Schmalhausen (*l. c.*, Pl. VIII., fig. 5) of about the same size as our leaves, which have otherwise all the characters of the Russian plant. They are distinctly stalked, somewhat leathery-looking, divided into leaflets, which are arranged fan-like ; there are 6 to 10 of such leaflets.

The lateral leaflets are small, cuneiform at the base, otherwise oval ; the middle ones much longer, cuneiform, obtuse at the apex. The veins are pretty numerous ; they are thickish at base, whence they divide several times, becoming thinner towards the apex.

I have thus hardly any doubt that our plant is identical with Mr. Schmalhausen's species. The Gingko-like nature of the leaves is fully evident and the leaves must have belonged to a tree quite closely allied to *Gingko* : altogether this living form has many more representatives amongst the fossil flora.

Occurrence : This interesting species occurred together with *Platypergum balli* in the Barákar group in the Sukri river, west of Gurtur, Auranga coalfield.

2.—TAXODINEÆ.

Genus : **CYCLOPITYS, Schmalh.**

1879. Beiträge zur Jurafloren Russlands, pp. 39, 88, &c.

Another rather peculiar coniferous plant was described by Mr. Schmalhausen under the above name ; it bears however a very strong equisetaceous aspect. Its diagnosis is the following :—

“*Folia verticillata, deplanato linearia, apice acuta, nervo medio valido percursu transverse tenuissime rugulosa.*” Mr. Schmalhausen compares his fossil plant with the living *Sciadopitys verticillata*, which is found in Japan. *Pinus nordenskiöldi* which was described by Heer amongst the arctic flora, belongs, according to Schmalhausen, to the same genus, and forms one of the two species of *Cyclopitys*, as *C. nordenskiöldi*, the other being *Cycl. heeri*, Schmalh.

The most peculiar character thus appears to be the disposition of the leaves in whorls, in a plant which is placed with the *Coniferae*. With regard to this I think certain plant remains which I collected in 1881 will have to be placed with *Cyclopitys*, although the leaves are dichotomous, but they are disposed in whorls and show I think a faint transverse wrinkling.

While thus correlating our fossil with *Cyclopitys*, Schmalh., I cannot agree with Mr. Schmalhausen in his proposal to refer² my *Annularia australis*³ also to his genus *Cyclopitys*. It is true there is a certain similarity between the leaf whorls; but this proves nothing. *Annularia australis* is from beds which are truly palaeozoic and far below the real *Glossopteris*-beds; and besides this, there is no wrinkling upon the leaf surface, which as it appears, Mr. Schmalhausen would consider as an important character; at least the two specimens which I figured and which were the only ones at my disposal for description, did not show anything of the kind; so I think it has to remain as *Annularia australis*, Fstn.

For the new species of *Cyclopitys* I propose the name—

CYCLOPITYS DICHOTOMA, n. sp. Pl. IIIA, figs. 3, 4; IVA, fig. 6.

Caule striato; foliis 5, pluribusque, coriaceis, verticillatim positis, nervo mediano valido percursis, e basi singulis dehinc bis—terque dichotome furcatis, ut videtur, transverse tenuissime rugulosis.

I have figured three specimens (almost the only ones collected) from which the above diagnosis was drawn.

The stalk or stem is striated, as is shown in fig. 3, Pl. IIIA, and in fig. 6, Pl. IVA. The leaves are disposed in whorls. Their number is various. Our specimens exhibit five leaves (counted at the place of insertion); but there may have been more. The leaves appear to have been leathery and their chief character is that they are forked, as a rule twice, but occasionally three times. They are traversed by a thickish median vein, which partakes of the dichotomy of the leaves. Otherwise the leaf substance appears to be transversely wrinkled. The leaves are longer and

¹ "These are long narrowly lineary leaves with a pretty thick midrib, on both sides of which there sometimes occur transverse wrinkles."

² Pflanzenpaläontolog. Beiträge: Bull. de l'Acad. Imp. d. Sc., Tome XXVIII, pp. 426-438, 1883.

³ Palmoz. und mesoz. Flora d. östl. Australiens: Palaeontographica, Supplm. III, Lief. 3, Heft 2—4, 1878-79, p. 154, Tab. VII, figs. 5, 6.

stronger than in either of the Russian species and at the apex they appear to have been obtusely pointed.

One of the specimens, figured Pl. IIIA, fig. 3, is a fragment of a branch showing two leafwhorls, of which the lower one is much more complete; this lower leaf-whorl shows five leaves at the point of insertion; the second leafwhorl shows only three leaves. All the leaves are forked twice, and this pretty regularly; but the two leaves immediately to the right of the stalk in the lower leafwhorl show a three-fold furcation.

The other specimen figured on Pl. IIIA, fig. 4, shows only a portion of one leafwhorl, while the third specimen on Pl. IVA, fig. 6, is very much like the first one.

Occurrence: *Barákar group*: Sukri river, west of Gurtur, Auranga coalfield (together with *Platypterygium balli* and *Rhipidopsis gingkoides*).

Genus: VOLTZIA, Bgt.

Several good specimens of *Voltzia* (*V. heterophylla*) were described and figured in my Talchir-Karharbári Flora; they came from the Karharbári beds of the Karharbári coalfield. At present I have to notice from analogous beds a fragmentary specimen of a coniferous branchlet which I think also belongs to *Voltzia*, without however intending to identify the species.

Occurrence: *Karharbári beds*: Outcrops south of Rájhera, Daltonganj coal-field.

3.—INCERTÆ SEDIS.

Besides the plants already described, there occurred in various beds, and at various places, certain winged seeds, the relation of which to certain plants and consequently their systematical position is more than doubtful. They may be seeds of some of the described coniferous plants or of the genus *Nöggerathiopsis*. They resemble very much similar seeds described by Prof. Heer under the name *Samaropsis*, and I have previously quoted them under that name.

Occurrence: *Talchir group*: North-west of Rikba, Chano basin, Káranpura coal-field, and north side of Latiahar hill, Auranga coalfield (Pl. XIIA, figs. 7—15).

Karharbári beds: Outcrops south of Rájhera, Daltonganj coalfield (Pl. XIVA, figs. 8, 9). Also outcrops at Singra, 5 miles north of Daltonganj, Daltonganj coalfield.

Raniganj group: Garhi river, south of Tandwa, Káranpura coalfield (Pl. VA, figs. 8, a, b, c, d, e).

Transitional beds (like *Máhadévas*): North face of Latiahar hill, Auranga coalfield (fossils in red shale).

Also those peculiar scale-like fossils, which I have previously quoted and figured under the name "*Squamæ gymnospermorum*," occurred again at several places. But their nature remains equally doubtful, and their occurrence is only interesting as illustrating further their wide distribution under similar circumstances.

Occurrence : *Barákar group* : Bishanpur river, $3\frac{1}{2}$ miles south-east of Bálumáth, Káránpúra coalfield.

Raniganj group : Ganespur river, west of Burgaon, Káránpura coalfield (Pl. V A, fig. 2). Also : inlier, $1\frac{1}{4}$ mile north of Jaguldagga, Auranga coalfield.

Transitional beds (like *Máhadevas*) : North face of Latiahar hill, Auranga coalfield.

PALÆONTOLOGICAL RESULTS.

The general palæontological results, with reference to the foregoing pages may be briefly summarised thus :—

1. The Talchir shales of the Chano basin, Káránpura coalfield, yielded a great number of interesting fossils, several of which prove further the close connection of this group with the Karhabári beds.

The occurrence of *Glossopteris* in these Talchir shales, which was not quite established previously, is now proved beyond any doubt; for several quite distinct specimens, representing at least two species, were collected.

Also a true *Vertebraria* is figured from the Talchir group of the South-Rewah Gondwána basin. Two new localities for Talchir fossils were discovered by myself, viz., at the northern base of the Latiahar hill, in the Auranga coalfield, and at the northern margin of the Hútár coalfield, south of Nowadih village.

There is thus no doubt that the genera *Glossopteris* and *Vertebraria*, which afterwards in the Damuda division became so very numerous, already existed in the time of the Talchir shales, though the characteristic fossil of these is *Gangamopteris*.

2. A further extension was also proved for the Karhabári beds, for it appears that at least the two lower seams of the Daltonganj coalfield belong to this horizon, as can be judged from the fossils of the outcrops at Singra (north of Daltonganj) and south of Rájhera.

I would feel also inclined to place in the Karhabári horizon the outcrops immediately above Talchirs at the northern margin of the Hútár coalfield south of Nowadilh village, as well as the outcrops at Umeria-Kalesar (S. Rewah).

The fossils of these Karhabári beds completely correspond with those in the Karhabári coalfield—*Glossopteris* being almost as numerous as *Gangamopteris*, both showing a great number of specimens.

These Karhabári beds of the Daltonganj coalfield (and probably also of the Hútár and South-Rewah coalfields) would thus form a connecting link between the same beds of the Karhabári and Mohpáni coalfields, in the latter of which I showed their existence in 1878.

3. The Barákar group, generally speaking, showed the same relations as in the Raniganj coalfield. But at one place, in the Auranga coalfield (Sukri river west of Gurtur), this group (stratigraphically speaking) yielded rather interesting fossils, showing an association of various species of *Glossopteris*, and two species of *Macrotæniopteris* (*Macrot.* *seddeni* of the Kámthi group, and *Macrot.* *danaoides*

of the Barákar and Raniganj groups) with a true cycadeaceous plant (*Platypergium balli*), and with coniferous plants, analogous forms of which are elsewhere known only from jurassic beds (*Rhipidopsis gingkoides* and *Cyclopitys* from the Russian-Siberian jurassic beds).

This shows pretty clearly how difficult it is to divide into distinctly separate groups the Damuda division of the Gondwána system from a palaeontological point of view, though from a petrological point of view there may be no objection to such a separation. The circumstance does not however at all diminish the value of the fossils of the Damuda division as a whole with regard to their correlation with other strata and fixing, approximately at least, their age. I shall mention a similar mixture of forms in the fossil flora of the coalbeds of Tong-King, which I shall notice further on.

4. The Ironstone shales of the South-Káranpura coalfield yielded a good number of fossils, which though rather fragmentary exhibited the interesting fact that they mostly agree with species of the Raniganj group elsewhere.

5. The fossils of the Raniganj group showed pretty well the same relations as the same group in the other Bengal coalfields.

6. Interesting observations were made (in continuation of Mr. Ball's original examination) with regard to the red shales of the Latiahar hill. These red shales contain such plant remains as usually occur in lower-Gondwánas only; but from a stratigraphical point of view it appears almost beyond any doubt that these shales belong to a higher horizon, and they were placed in the Máhadévas.

Besides this locality there are also others in South-Rewah (Parsora, Daigaon, &c.) where similar relations were observed, which only show, that the Gondwánas, though they can be divided into two portions, an "upper" and "lower" one, yet form a continuous system. For these latter localities, I have previously proposed to establish a separate division, *viz.*, Transitional beds, which perhaps would best answer for the purpose.

GENERAL REVIEW OF THE LOWER-GONDWÁNAS AND THEIR FOSSILS.

In the second volume of the Gondwána Flora a general review of the fossils of the upper-Gondwánas was given, and I think it will therefore be desirable to give also a general view of the fossils of the lower-Gondwánas, including under the heading of Transitional beds those localities which according to stratigraphical relations belong to a higher horizon while they yielded fossils of lower-Gondwána type. I shall first make a few remarks about the various groups, their distribution, &c., and after that I shall give a general review of all the fossils described from the lower-Gondwánas.

A.—Lower-Gondwánas.

Three divisions¹ are distinguished: (1) Talchir, (2) Damuda, and (3) Panchet divisions (in ascending order).

¹ These three divisions of the lower-Gondwánas were introduced by Mr. W. T. Blanford in 1861.

1. TALCHIR DIVISION.—This again is divided into two groups, which are in ascending order.

(a) *Talchir group*.—1859, Blanford: Talchir coalfield: Mem. Geolog. Survey of India, Vol. I.

This group forms the base of the whole system and is very interesting both in its deposits and in its fossils. It consists at the base generally of a boulder bed, which is believed to have been formed by floating ice; otherwise it consists of sandstones and shales (bluish grey or olive green, fine, earthy); these latter are fossiliferous. Fossils were known hitherto from the Karaun coalfield, Lower Bengal, whence the first specimens were collected; they yielded the type form of *Gangamopteris cyclopterooides*; from the Káranpura coalfield, Hazáribágh district, where I collected in 1881; from the Auranga coalfield, made known also in 1881; from the Hútár coalfield, where I collected in 1882; and last from the South-Rewah coalfield (collected by Mr. Th. Hughes and Sub-Assistant Hira Lal).

The palaeontological relations of this group now stand thus:

Vertebraria takes here its beginning (Behia-Burgaon in South-Rewah); also *Glossopteris* as now proved beyond any doubt (Chano basin, Káranpura coalfield). The predominant fossil however is *Gangamopteris*, most species of which pass on into the next group. Also *Nöggerathiopsis*, which becomes so numerous, occurs here for the first time (Chano basin, Káranpura coalfield, and north base of Latiahar hill, Auranga coalfield).

(b) *Karharbári beds*: the coal-bearing portion of the Talchir division.—1877, Feistmantel: Rec. Geol. Surv. India, Vol. X, Pt. 3, pp. 137—139. 1878, W. T. Blanford: Rec. Geol. Surv., India, Vol. XI, Pt. 1. 1879, Feistmantel: Talchir-Karharbári Flora; Gondwána Flora, Vol. III, Pt. 1, p. 3, *et seq.*

The establishing of this group appeared necessary after the thorough study of the flora of the coal-beds of the Karharbári coalfield (Bengal), which had previously been included in the Barákar group; but the flora distinctly showed their close connection with the Talchir group. From the Karharbári coalfield, the name of the group was taken, but I have shown that it exists also in the Daltonganj coalfield, Palamow, Western Bengal; in the Mohpáni coalfield, and probably also in the Sháhpur coalfield, both in the Sátpura range. I also believe that the fossils of Umria-Kalesar and Khaira in South-Rewah, indicate pretty distinctly the Karharbári horizon.

In these beds *Schizoneura* appears; *Vertebraria* is more numerous; *Glossopteris* is numerous, but still *Gangamopteris* dominates. *Voltzia* is not uncommon, and *Nöggerathiopsis* is largely represented. Also certain seeds are rather frequent.

2. DAMUDA DIVISION.—Especially characterised by the predominance of *Glossopteris*; *Gangamopteris* is very subordinate. *Vertebraria* very numerous, and *Schizoneura*, especially in the upper portions.

This division is again divided into three groups, but I think they are, generally speaking, easier to be distinguished on stratigraphical than on palaeontological

characters; only a long experience with the fossils gives some facility in distinguishing the Barákar and Raniganj groups on palaeontological grounds, especially in those cases where they are not typically developed.

(a) *Barákar group*.—1861, Oldham (T.) : Additional remarks on the geology, relations, &c., of the rocks in Bengal, &c.; Mem., Geol. Surv. of India, Vol. III, p. 212.

The above name was proposed by Dr. Oldham in 1861 for the lowest group of the Damuda division, up to that time simply called "lower Damudas", since the corresponding term, "upper Damudas" had also to be replaced by another name (the present Jabalpur group), as a group belonging to the upper-Gondwána.

The Barákar group is richly coal-bearing, and we find it in most of the coal-fields; at first it was established in the Raniganj coalfield and the name is taken from the Barákar river, as well as from the place Barákar (west of Raniganj), where it is typically developed.

The distinction of this group from the equally coal-bearing Raniganj group is well marked stratigraphically in the eastern coalfields of the Damuda valley, but the palaeontological relations are very close; *Vertebraria*, *Glossopteris* and *Nöggerathiopsis* are equally numerous in both. *Tritygia* and *Macrotæniopteris* are also found in the Barákars. The distinctive palaeontological characters of the Barákar group from the Raniganj group are only negative, consisting in the lesser development of *Schizoneura* and in the want of *Phyllotheca* in the Barákar group.

The two forms of coniferous plants described in the present memoir from the Barákars, viz., *Rhipidopsis* and *Cyclopitys* are only specialities.

(b) *Ironstone shales*.—1861, W. T. Blanford: On the Geology, &c., of the Raniganj coalfield; Mem. Geol. Survey of India, Vol. III, p. 29.

This horizon is easily distinguishable by its petrological characters, the rocks composing it consisting chiefly of ferruginous and carbonaceous shales in which clay-ironstones are imbedded or with which they alternate. It is present in most of the Bengal coalfields; and it is considered that the Motúr beds¹ of the Sátpura basin are on the same horizon.

With regard to fossils this group appears closely connected with the next, viz., with the Raniganj group. The fossils which I collected in these beds near Jainagar in the South Káranpura coalfield have greatly enlarged the list of fossils of this horizon.

(c) *Raniganj Group*.—1861, W. T. Blanford: report on the Raniganj coal-field; Mem. Geol. Sur., Ind., Vol. III.

This group contains rich coal-deposits, especially in the Bengal coalfields; it was first described from the Raniganj coalfield, so called from the chief town within its area, and subsequently identified in all the Damuda valley coalfields. Further to the west it has chiefly been recognised by palaeontological evidence as in

¹ H. B. Medlicott: Mem. Geol. Surv., India, Vol. X, p. 29 (1871), 1874.

the Auranga, Ramkola, and Tatapáni coalfields ; it is also typically represented in the Gopat area of the South-Rewah Gondwána basin.

There is no doubt that the Bijori horizon of the Sátpura basin,¹ and the Kámthi group² of the Nágpúr area and of the Raigarh-Hingir coalfield³ palaeontologically represent the Raniganj group.

The Míngli shales, containing *Estheria mangaliensis*, Jones, are also placed here.

The fossils of the Raniganj group are on the whole, as already stated, the same as in the Barákar group ; but one character can be pointed out, *viz.*, that where this group is typically developed, it contains a good proportion of *Schizoneura* ; this is the case in the Bengal coalfields, in the Ramkola-Tatapáni coalfields, in the Gopat area (South-Rewah), in the Raigarh-Hingir coalfield, and in the Bijori horizon, Sátpura basin. Otherwise this group contains *Phyllotheca*,⁴ (Raniganj coalfield, Rajmahál hills and Nágpúr area), *Trizygia*, numerous species of *Glossopteris*, *Nöggerathiopsis*, and some others.

3. PANCHET DIVISION.—1878, W. T. Blanford : Rec. Geol. Sur. Ind., Vol. XI.

(a) *Panchet group*.—1861, W. T. Blanford : report on the Raniganj coalfield ; Mem. Geol. Sur. Ind., Vol. III, p. 126.

This group was first described from the Raniganj coalfield, where it is typically developed, and where it contains some interesting fossils, *viz.*, remains of *Labyrinthodontia* and *Dicynodontia*, besides plants, amongst which *Schizoneura*, the same as in the Raniganj group, is worthy of notice; besides this, there are known a *Tæniopteris* (*Angiopteridium*) and some other ferns.

Representatives of this group were also reported from other basins, but chiefly upon stratigraphical evidence ; it is considered that the Almod beds (of H. B. Medlicott) may represent this group in the Satpura basin.

B.—Transitional beds.

1882. Feistmantel : Fossil Flora of the South-Rewah Gondwána basin ; Gondwána Flora, Vol. IV, Pt. 1, pp. 5-7.

1885. T. W. H. Hughes : Southern coalfields of the Rewah Gondwána basin. Mem. Geol. Surv., India, Vol. XXI, Pt. 3, p. 72.

I proposed (*l. c.*) this division to take a place between the hitherto used two divisions (upper and lower) of the Gondwána system and to comprise such strata as contain a flora of lower-Gondwána character, while from a stratigraphical point of view they bear a great resemblance to upper-Gondwána rocks. Deposits of this kind are described in the present memoir in the Auranga coalfield, on the northern face of the Latiahar hill.

In my memoir on the South-Rewah Gondwána Flora two such localities in that area are specially noticed—Parsora near Beli and Daigaon on the Johilla, but from

¹ H. B. Medlicott : Mem. Geol. Surv., India, Vol. X, p. 27, 1874.

² W. T. Blanford : Rec. Geol. Surv., India, Vol. IV, p. 50, 1870. Mem. Geol. Surv., India, Vol. IX, p. 329.

³ V. Ball : Rec. Geol. Surv., India, Vol. VIII, p. 113, etc.

⁴ Two species.

Mr. Hughes' recent report I see that these deposits are of wide extension in that field. Mr. Hughes classes them under the heading of "Supra-Barákars (*i. e.*, p. 71) and on page 72 he writes :—

" From my published notes in the Records of the Survey it may be gathered how strongly I was of opinion that in the valley of the Johilla the strata immediately above the unquestionable coal-measures were Máhádévas. On reconsideration, however, I think the suggestion of Dr. Feistmantel in the *Palaeontologia India* embodies a more reasonable view of the situation, and that some portion of the area mapped as Supra-Barákars should form an intermediate zone between the Mahádévas and the coal-measures."

Several of the localities which Mr. Hughes places in this category, I have quoted as belonging to the Raniganj group, judging from the fossils only. The palaeontological relations of these beds have been indicated on preceding pages.

SYSTEMATICAL REVIEW OF THE FOSSILS OF THE LOWER-GONDWÁNAS.

A.—PLANTÆ.

1.—CRYPTOGAMÆ OR ACOTYLEDONES.

a.—*PTERIDOPHYTA*.

Genus : SCHIZONEURA, *Schimp.* and *Moug.*, 1814.

(1) SCHIZONEURA GONDWANENSIS, *Fslm.*, 1876.

1876. Rec. Geol. Surv., India, Vol. IX, p. 69. 1880. Pal. India: Gondwána Flora, Vol. III, p. 61, and plates; also Vol. IV, Pt. 1 (1882).

This species is of particular interest from its close resemblance to *Schizoneura paradoxa*, Schimp (lower trias), and from its frequent occurrence in the lower-Gondwánas, especially in the Raniganj group.

Transitional beds : Auranga coalfield (north face of Latiahar hill), and South-Rewah (one or two places in the Sohágpur district).

Panchet group : Raniganj coalfield (near Maitúr, north-west of Asansol).

Raniganj group (including Kámthis) : Raniganj and Jharia coalfields (very numerous); Bokáro coalfield (one locality); Káranpura coalfield (one locality); Auranga coalfield (inlier 1½ miles north of Jaguldagga); Ramkola and Tatapáni coalfield; Raigarh-Hingir coalfield (Garjan hills); South-Rewah Gondwána basin (places in the Gopat area, on the Son river and in the Sohágpur district).

Barákar group : Lumki hill Karharbári coalfield; Auranga coalfield (Sukri river, west of Gurtur).

Karharbári beds : Karharbári coalfield; Mohpáni coalfield (Sátpura basin).

(2) SCHIZONEURA, comp. MERIANI, *Schimp.*

1879. Feistmantel : Pal. Ind. ; Talchir-Kurharbári Flora, p. 8, Pt. 1, figs. 6-7.

Some specimens are doubtfully referred here—

Karharbári beds : Karharbári coalfield.

Some specimens from the Talchir shales, Karaun coalfield, also appear to belong to *Schizoneura*, so that this genus would appear to range in India from the Talchirs up into the Transitional beds.

Genus : PHYLLOTHIECA, *Bgt.*, 1828.

A genus known from jurassics in Europe, Russian Siberia, North-Eastern Siberia, China, Newcastle beds of New-South-Wales. In India there are two species.

(3) PHYLLOTHECA indica, *Bunb.*, 1862.

1880. Feistmantel : Pal. Ind. ; Gondw. Flora, Vol. III, Pt. 2, p. 67 *et seq.*

Raniganj group (includg. Kámthis) : Raniganj coalfield ; Nágpur area. Lately it was also identified from the coal-measures of Tong-King (basin of Hon-Gac).

(4) PHYLLOTHECA ROBUSTA, *Fslm.*

1880. Pal. Ind. ; Gondw. Flora, Vol. III Pt. 2, pp. 68-69, fig.

Raniganj group : near Dubrajpur, Gopicandar area, Rájmahál hills.

Genus : TRIZYGIA, *Royle*, 1839.

Represents the genus *Sphenophyllum* ; is a most interesting form.

(5) TRIZYGIA SPECIOSA, *Royle*, 1839.

1880. Feistmantel : *I. c.*, p. 69 and fig.

Raniganj group : Raniganj coalfield ; Sikkim (according to Sir J. D. Hooker) ; South-Rewah Gondwána basin (Sohágpur district) ; Satpúra basin.

Barákar group : Bokáro coalfield ; Auranga coalfield (west of Murup) ; Talchir coalfield (near Gopálprasád).

Genus : VERTEBRARIA,

A very numerous fossil in the lower-Gondwána, though its real nature is as yet far from being understood. It occurs besides in the Newcastle beds in New South Wales.

6.—VERTEBRARIA INDICA, *Royle*, 1839.

1880. Feistmantel : *I. c.*, and Vol. IV, Pt. 1.

This species is most widely distributed.

Transitional beds : Auranga coalfield (north face of Latiahar hill) ; South-Rewah Gondwána basin (several places in the Sohágpur area).

Raniganj group : In most of the coalfields.

Barákar group : In most of the coalfields.

Karharbári beds : Karharbári coalfield ; Daltonganj coalfield.

Talchir group : South-Rewah Gondwána basin (near Behia Bargaon).

β. FILICES.

Order: MARATTIACEÆ.

Genus: DANÆOPSIS, Heer.

7.—DANÆOPSIS HUGHESI, Fstn., 1882.

1882. Pal. Ind. ; Gondwána Flora, Vol. IV, Pt. 1, p. 25 *et seq.*, with numerous figures.

A most interesting fern from its size, its relations and its occurrence.

Transitional beds : South-Rewah Gondwána basin (Sohágpur district, Parsora near Beli).

Order: CYATHEACEÆ.

Genus: CYATHEA, Linn.

8—CYATHEA comp. TCHIATCHEFFI, Schmalh.

1880. Feistmantel : *I.c.*, p. 75 and fig.

Raniganj group : Káranpura coalfield (3 miles south-east of Tandwa).

Barákar group : Talchir coalfield (near Talchir).

Genus: SPHENOPTERIS, Bgt., 1828.

9.—SPHENOPTERIS POLYMORPHA, Fstn., 1876.

1876. Feistmantel : J. As. Soc. Bengal, Vol. XLV, pp. 356—358 and fig. 1880. Pal. Ind. ; Gondwána Flora, Vol. III, Pl. 2, p. 76, and fig.

Raniganj group : Raniganj coalfield ; South-Rewah basin (several places).

Barákar group : Lumki hill, Karharbári coalfield.

Genus: DICKSONIA, L'Hérit.

10.—DICKSONIA HUGHESI, Fstn., 1880.

1880. Pal. Ind. ; Gondwána Flora, Vol. III, p. 52 fig. Also Vol. IV (1882), Pt. 1, p. 25, and fig.

Raniganj group : Jharia coalfield ; South-Rewah Gondwána basin (Son area) ; Sátpura basin (Bijori horizon).

Order: POLYPODIACEÆ.

Type: ASPLENIUM, Linn.

11.—ASPLENIUM WHITBYENSE, Heer (incldg. Alethopt. indica, Oldh. and Morr.).

1882. Pal. Ind. ; Gondwána Flora, Vol. IV, Pt. 1, p. 28, etc.

Transitional beds : South-Rewah Gondwána basin (Parsora near Beli).

12.—*ASPLENIUM comp. WHITBYENSE*, *Heer*.1880. *Pal. Ind.*; *Gondwána Flora*, Vol. III, and 1882, *ibid.*, Vol. IV.*Raniganj group*: Raniganj coalfield; Jharia coalfield; South-Rewah Gondwána basin (on the Mahan river).Type: *POLYPODIUM*, *Linn.*13.—*ALETHOPTERIS LINDLEYANA*, *Royle*, 1839.1880. Feistmantel: *Pal. Ind.*; *Gondwána Flora*, Vol. III, Pt. 2, p. 80, etc., and fig.*Raniganj group*: Raniganj coalfield.Type: *PHEGOPTERIS*, Metten.14.—*ALETHOPTERIS PHEGOPTEROIDES*, *Fstn.*, 1876.1876. *Journ. As. Soc.*, Beng., Vol. XLV, pp. 362—364, and fig. 1880. *Pal. Ind.*; *Gondwána Flora*, Vol. III, Pt. 2, p. 81.*Raniganj group*: Raniganj coalfield.*Pecopterideæ incertæ sedis.*15.—*PECOPTERIS CONCINNA*, *Presl.*, 1838.1880. Feistmantel: *Pal. Ind.*; *Gondwána Flora*, Vol. III, Pt. 2, p. 82, and fig.

In Europe a rhaetic species.

Panchet group: Raniganj coalfield (North-west of Asansol).Genus: *MERIANOPTERIS*, *Heer*, 1877.16.—*MERIANOPTERIS MAJOR*, *Fstn.*, 1880.1880. *Pal. Ind.*; *Gondwána Flora*, Vol. III, Pt. 2, p. 83, and fig.*Raniganj group*: Raniganj coalfield.Order: **NEUROPTERIDEÆ and CYCLOPTERIDEÆ (Cardiopterideæ)**.Genus: *NEUROPTERIDIUM*, *Schimp*, 1879.

This contains the single-pinnate neuropteroid plants, which in Europe are represented in lower triassic rocks.

17.—*NEUROPTERIDIUM VALIDUM*, *Fstn.*, 1879.1879. *Pal. Ind.*; *Gondwána Flora*, Vol. III, Pt. 1, pp. 10—11 and fig.*Karharbári beds*: Karharbári coalfields.Genus: *CYCLOPTERIS*, *Bgt.*, 1828.18.—*CYCLOPTERIS PACHYRHACHIS*, *Göpp.*, 1836.1880. Feistmantel: *Pal. Ind.*; *Gondwána Flora*, Vol. III, Pt. 2, p. 84, and fig.

In Europe a rhaetic species.

Panchet group: Raniganj coalfield (North-west of Asansol).

Order: LOMATOPTERIDEÆ and PACHYPTERIDEÆ.

Genus: THINNFELDIA, *Ettingsh.*, 1852.

19.—THINNFELDIA comp. ODONTOPTEROIDES, *Fstn.*

1879. Flora des oestl. Australiens: Palaeontographica, Suppl. III, Liefl. III, pp. 105, 165. 1880. Gondwána Flora, Vol. III, Pt. 2, p. 85, and fig.

There are several specimens which have, I think, to be correlated with this species.

Transitional beds: South-Rewah Gondwána basin (Parsora, near Beli).

Panchet group: Ramkola and Tatapáni coalfields (at two localities).

Order: TÆNIOPTERIDEÆ.

Genus: MACROTÆNIOPTERIS, *Schimp.*, 1869.

This genus includes the broadleaved forms, especially represented in mesozoic formations. In India there are several species numerously represented in the upper-Gondwánas, but there are two good species also in the lower-Gondwánas.

20.—MACROTÆNIOPTERIS DANÆOIDES, *Royle*, 1839.

1876. Feistmantel: Jour. As. Soc. Beng., Vol. XLV, p. 365, and fig. 1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 88, and fig.

Raniganj group: Raniganj coalfield; Jharia coalfield; Auranga coalfield (inlyer $1\frac{1}{4}$ mile north of Jaguldagga); Nágpur area (near Kámthi).

Ironstones shales: South Káranpura coalfield (Naikori river, near Jainagar).

Barakar group: Rájmahál hills (near Burgo); Auranga coalfield (Sukri river, west of Gurtúr).

21.—MACROTÆNIOPTERIS FEDDENI, *Fstn.*, 1876.

1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 89, fig.

Raniganj group: Nágpur area, near Kámthi; South-Rewah Gondwána basin (on the Son river).

Barákar group: Auranga coalfield (Sukri river, west of Gurtur).

This species has also been identified from the coal strata of Tong-King (Hon-Gâc basin).

Type: VITTARIA, Swartz

Genus: PALÆOVITTARIA, *Fstn.*, 1876.

22.—PALÆOVITTARIA KURZI, *Fstn.*, 1876.

1876. Journ. As. Soc. Beng., Vol. XLV., p. 368, and fig.

Raniganj group: Raniganj coalfield. Identified also amongst the plants from the coal-bearing beds of Tong-King.

Genus: OLEANDRIDIUM, Schimp, 1869.

23.—OLEANDRIDIUM comp. STENONEURON. Schimp, 1869.

1880. Feistmantel: Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 92, and fig.

Raniganj group: Raniganj coalfield (North-west of Asansol).

Genus: ANGIOPTERIDIUM, Schimp, 1869.

24.—ANGIOPTERIDIUM comp. MC'CLELLANDI, Schimp.

1880. Feistmantel: Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 92, and fig.

Raniganj group: Nágpúr area (near Kamthi); also South-Rewah Gondwána basin.

25.—ANGIOP., INFARCTUM Fstn., 1880.

1880. Feistmantel: l. c., p. 93, and fig.

Raniganj group: Raniganj coalfield.

Order: DICTYOTÆNIOPTERIDEÆ.

Genus: GLOSSOPTERIS, Bgt., 1828.

This is the most numerous genus in the lower-Gondwánas. It also occurs in the lower and upper coal-measures (Newcastle beds) in Australia and has recently been identified from the coal-bearing beds of Tong-King.

I have, for easier reference, arranged the various species according to their form and net-venation into several groups.

aa.—Narrow-leaved forms.

26.—GLOSSOPTERIS ANGUSTIFOLIA, Bgt., 1828.

1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 105, etc., and fig.

Raniganj group: Rajmahal hills; Raniganj coalfield; Káranpura coalfield; Ramkola coalfield; South-Rewah basin (many localities); Satpura basin; Wardha coalfield.

Ironstone shales: South Káranpúra coalfield (Naikori river, near Jainagar).

Barakár group: Talchir coalfield; Auranga coalfield; South-Rewah basin. It also occurs at the locality Pinaora, Singwara district (South Rewah), the fossils at which I thought might rather represent the Karharbári horizon.

27.—GLOSSOPTERIS LEPTONEURA, Bunn., 1861.

1861. Quar. Journ. Geol. Soc. London, Vol. XVII, p. 330, etc., and fig.

Raniganj (Kamthi) *group*: Nágpúr area.

28.—GLOSSOPTERIS FORMOSA, Fstn., 1880.

1880. Pal. Ind. Gondwána Flora., Vol. III, Pt. 2, p. 106, etc., and fig.

Raniganj group: Raniganj coalfield; Káranpúra coalfield; Rámkola coalfield; South-Rewah basin.

29.—*GLOSSOPTERIS TÆNIOIDES*, *Fstn.*, 1882.

1882. Pal. Ind.; Gondwána Flora, Vol. IV, Pt. 1, p. 36, and fig.

Barákar group: (Karharbári beds) Pínaora,¹ Singwára district, South-Rewah basin.

bb.—Forms with narrow nets.

30.—*GLOSSOPTERIS COMMUNIS*, *Fstn.*, 1876.

1876. Journ. As. Soc. Beng., Vol. XLV, p. 375, and fig. 1880. Pal. Ind.; Gondwána Flora, Vol. IV. Pt. 2, p. 98, etc., and fig.

This species is not only known in the Transitional beds, but also in true upper-Gondwánas, otherwise it is the most numerous species of the lower-Gondwánas. Fructificating specimens show longitudinal rows of round sori.

Upper-Gondwánas: Jabalpur group on the Sher river, Sátpura basin.

Transitional beds (Máhadevas): Auranga coalfield (northern face of Latiahar hill); South-Rewah basin (Daigaon, west of Pali, etc.).

Panchet group: Raniganj coalfield; Rámkola coalfield.

Raniganj (Kamthi) *group*: In almost all coalfields.

Ironstone shales: Raniganj coalfield; South-Káranpúra coalfield (Naikori river near Jainagar).

Barákar group: In most of the coalfields.

Karhárbari beds: Karhárbari coalfield; Daltonganj coalfield; Mohpáni coalfield.

Talchir group: Chano basin, Káranpúra coalfield.

31.—*GLOSSOPTERIS COMMUNIS*, var. *STENONEURA*, *Fstn.*

1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 99.

Raniganj group: Raniganj coalfield.

Barákar group: Raniganj coalfield; Káranpúra coalfield.

32.—*GLOSSOPTERIS INTERMITTENS*, *Fstn.*, 1880.

1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 99.

Barákar group: Raniganj coalfield.

33.—*GLOSSOPTERIS STRICTA*, *Bunb.*, 1861.

1861. Quar. Journ. Geol. Soc. London, Vol. XVII, p. 331, and fig. 1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 100, and fig.

Kamthi (Raniganj) *group*: Nagpur area; Wardha coalfield (Isapúr, near Chanda); South-Rewah Gondwána basin.

34.—*GLOSSOPTERIS MUSÆFOLIA*, *Bunb.*, 1861.

1861. L. c. pp. 329—330, and fig.

This species is somewhat doubtful and was not met with again.

Kamthi group: Nágpúr area.

¹ In his recent Report (*l. c.*, p. 39) Mr. Hughes mentions this locality by the name of Amádóngri, and he places it, as all the other localities with Karharbári fossils, under the heading Barákar group, being unable on stratigraphical or petrographical grounds to indicate any separation.

35.—*GLOSSOPTERIS INDICA*, Schimp., 1869.

1828. *Glossopt. browniana*, var. *indica*, Bgt.: Hist. vég. foss., p. 223, tab. 62, fig. 2, B.

1880. Feistmantel: Pal. Ind.; Gondwāna Flora, Vol. III, Pt. 2, p. 101, figures.

Next to *Glossopt. communis* the most numerous species; shows also a similar state of fructification.

Transitional beds (? Māhadēvas): Auranga coalfield (northern face of Latiahar hill), South-Rewah basin (Daigaon, &c.)

Panchet group: Raniganj coalfield (north-west of Asansol).

Raniganj group: Raniganj coalfield; Kāranpura coalfield; South-Rewah Gondwāna basin (Gopat and Son areas); Nāgpur area.

Ironstone-shales: South Kāranpura coalfield (Naikori river, near Jainagar).

Barākar group: Raniganj coalfield; Ramkola-Tatapáni coalfield; Talchir coalfield; Kāranpura coalfield; South-Rewah Gondwāna basin.

Karharbāri beds: Daltonganj coalfield; Pinaora, in South-Rewah.

Talchir group: Kāranpura coalfield (Chano basin, north-west of Rikba).

cc.—Intermediate forms.

36.—*GLOSSOPTERIS BROWNIANA*, Bgt., 1828.

1828. *Glossopteris browniana*, *l. c.*, p. 223, Pl. 62, fig. 1. 1880. Pal. Ind.; Gondwāna Flora, Vol. III, Pt. 2, p. 102, fig.

This is supposed to be the Australian variety of the original *Glossopt. browniana*, but the Indian form appears to show a similar net-venation only; while the state of fructification in the Indian specimens is similar to that of *Gl. communis* and *Gl. indica*, in the Australian *Gl. browniana* the fructification appears (according to Carruthers) to be different; so that, as I said once before, in spite of the similar net-venation, both the forms, judging from the fructification, would belong to different genera, *viz.*, *Polypodium* and *Anthrophyum* respectively. In this statement, there is, I think, no inconsistency and no incorrectness.

Raniganj group: Raniganj coalfield; Raigarh-Hingir coalfield; South-Rewah Gondwāna basin (Gopat area, Son river, and Sohāgpur district); Nāgpur area, specimens in fructification; Wardha coalfield.

Barākar group: Raniganj coalfield; Talchir coalfield; Ramkola-Tatapáni coalfield; Auranga coalfield; South-Rewah Gondwāna basin.

This species has also been identified amongst the fossil plants of Tong-King.

37.—*GLOSSOPTERIS CORDATA*, Fstn., 1882.

1882. Pal. Ind.; South-Rewah Gondwāna Flora; Gondwāna Flora, Vol. IV, Pt. 1., p. 34, fig.

Transitional beds: South-Rewah Gondwāna basin (hill between Karkoti and Malhādu). In my above work this locality is quoted under the heading of Raniganj group, while Mr. Hughes places it with his Supra-Barākars,¹ which correspond with my Transitional beds.²

¹ Mem. Geo. Soc., India, Vol. XXI, Pt. 3, p. 37.

² In Mr. Hughes' memoir the term 'Supra-Barākar' was not proposed to indicate any definite horizon, but only as a convenient expression for the rocks above the coal-measures, to which latter his description was mainly directed (see, *l. c.*, p. 71). H. B. M.

*dd.—Broad-netted forms.*38.—*GLOSSOPTERIS RETIFERA*, *Fstn.*, 1880.

1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 103, and fig.

Raniganj group: Raniganj coalfield; Káranpura coalfield; Ramkola coal-field; South-Rewah Gondwána basin; Sátpura basin.

Ironstone-shales: South Káranpura coalfield (Naikori river, near Jainagar).

Barákar group: Auranga coalfield (Sukri river, east-by-north of Rájbar).

39.—*GLOSSOPTERIS DAMUDICA*, *Fstn.*, 1880.

1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 105, fig.

Transitional beds (Máhadevas): Auranga coalfield (northern face of Latiahar hill); also in South-Rewah Gondwána basin (Kurábar).

Raniganj group: Káranpura coalfield; Ramkola coalfield; South-Rewah Gondwána basin; Sátpura basin; Nágpur area; Wardha coalfield.

Ironstone-shales: Raniganj coalfield (Kulti); South Káranpura coalfield (Naikori river).

Barákar group: Raniganj coalfield; Talchir coalfield; Auranga coalfield; Hútár coalfield; Ramkola coalfield; South-Rewah basin.

Karharbári beds: Karharbári coalfield (3rd seam).

40.—*GLOSSOPTERIS CONSPICUA*, *Fstn.*, 1880.1880. *L. c.*, p. 104, fig.

Raniganj group: Raniganj coalfield; Káranpura and Auranga coalfields.

Ironstone-shales: South Káranpura coalfield.

41.—*GLOSSOPTERIS DIVERGENS*, *Fstn.*, 1880.1880. *L. c.*, p. 104, fig.

Raniganj group: Raniganj coalfield.

*e.—Round-leaved forms.*42.—*GLOSSOPTERIS ORBICULARIS*, *Fstn.*, 1880.1880. *L. c.*, p. 107, fig.

Raniganj group: Raniganj coalfield.

*f.—Incertæ.*43.—*GLOSSOPTERIS DECIPiens*, *Fstn.*, 1879.

1879. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 1, p. 17, fig.

Karharbári beds: Karharbári coalfield; Daltonanj coalfield.

Order: **DICTYOPTERIDEÆ**.

In this the various species of *Gangamopteris* are most numerously represented, chiefly from the Karharbári beds and Talchir shales.

Genus: *GANGAMOPTERIS*, McCoy, 1875.

44.—*GANGAMOPTERIS CYCLOPTEROIDES*, Fstn., 1879.

1879. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 1, p. 12, fig. &c.; also this volume, Pt. 1.

This is the type form, originally described above (*l. c.*)

Bárakar group: Sháhpur coalfield, near Kotmi (doubtfully Karharbári beds); also South-Rewah basin (doubtfully Karharbári beds).

Karharbári beds: Karharbári coalfield; Daltonganj coalfield; Hútár coalfield.

Talchir shales: Karaun coalfield; Káranpura coalfield (Chano basin); Auranga coalfield (north base of Latiahár hill); Hútár coalfield; South-Rewah basin (at several places).

There were many varieties of this species distinguished which occur pretty constantly at one or the other locality in the Kaharbári beds and Talchir shales.

45.—*GANGAMOPT. CYCLOPTEROIDES*, var. *SUBAURICULATA*.

1879. *L. c.*, p. 13, fig.

Karharbári beds: Kaharbári coalfield; Daltonganj coalfield; also in South Rewah (Pinaora, doubtful).

Talchir shales: Káranpura coalfield (Chano basin); Auranga coalfield (northern base of Latiahár hill); Hútár coalfield.

46.—*GANGAMOPT. CYCLOPT.* var. *AREOLATA*.

1879. *L. c.*, p. 14, fig.

Karharbári beds: Karharbári coalfield.

Talchir shales: Káranpura coalfield (Chano basin).

47.—*GANGAMOPTERIS CYCLOPT.* var. *ATTENUATA*.

1879. *L. c.*, p. 14, fig.

Karharbári beds: Karharbári coalfield; Daltonganj, Hútár, and Mohpáni coalfields; also South-Rewah basin.

Talchir shales: Káranpura coalfield; Auranga coalfield.

48.—*GANGAMOPT. CYCLOPT.* var. *ACUMINATA*.

1885. In the present memoir.

Talchir group: Káranpura coalfield (Chano basin); Auranga coalfield (north base of Latiahár hill).

49.—*GANGAMOPT. CYCLOPT.* var. *CORDIFOLIA*.

1885. The present memoir.

Talchir group: Káranpura coalfield (Chano basin); Auranga coalfield (north base of Latiahár hill).

50.—*GANGAMOPT.* comp. *OBLIQUA*, *McCoy*, 1875.

1875. *Prodr. Palaeont. Victoria*, Dec. II, p. 13, fig.

Talchir group : Káranpura coalfield (Chano basin).

51.—*GANGAMOPTERIS BURIADICA*, *Fstmr.*, 1879.

1879. *Gondwána Flora*, Vol. III, Pt. 1, p. 15, fig.

Karharbári beds : Karharbári coalfield.

Talchir group : Káranpura coalfield (Chano basin). The identification from this group is, however, made with some reserve.

52.—*GANGAMOPTERIS MAJOR*, *Fstmr.*, 1879.

1879. *Gondwána Flora*, Vol. III, Pt. 1, p. 15, fig.

Karharbári beds : Kaharbári coalfield ; also South-Rewah (between Hárdi and Sárangpur).

Talchir shales : Káranpura coalfield (Chano basin) ; South-Rewah (Bareri).

53.—*GANGAMOPTERIS ANGUSTIFOLIA*, *McCoy*, 1875.

1875. *Prodr. Palaeont. Victoria*, Dec. II, p. 11, fig.

Karharbári beds : Karharbári coalfield.

Talchir shales : Karaun (Deoghar) coalfield ; Káranpura coalfield.

54.—*GANGAMOPTERIS ANTHROPHYOIDES*, *Fstmr.*, 1880.

1880. *Pal. Ind.* ; *Gondwána Flora*, Vol. III, Pt. 2, p. 108, fig.

Raniganj group : Raniganj coalfield ; Káranpura coalfield.

55.—*GANGAMOPTERIS WHITIANA*, *Fstmr.*, 1876.

1880. *Pal. Ind.*, *l. c.*, p. 109, fig.

Raniganj group : Raniganj coalfield.

56.—*GANGAMOPTERIS HUGNESI*, *Fstmr.*, 1876.

1880. *Pal. Ind.*, *l. c.*, p. 109, fig.

Kámthi (Raniganj) *group* : Nágpur area (near Kámthi).

Genus : *BELEMNOPTERIS*, *Fstmr.*, 1876.

1876. *Journ. As. Soc. Bengal*, Vol. XLV, p. 370.

57.—*BELEMNOPTERIS WOOD-MASONIANA*, *Fstmr.*, 1876.

1876. *L. c.*, p. 371, fig. 1880. *Pal. Ind.* ; *Gondwána Flora*, Vol. III, Pt. 2, p. 112, fig.

Raniganj group : Raniganj coalfield.

INCERTÆ SEDIS.

Here I have included several fossils doubtfully referred to *Sagenopteris* and some others.

58.—*SAGENOPTERIS (?) LONGIFOLIA, Fstn., 1880.*

1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 113, fig.

Raniganj group: Raniganj coalfield.59.—*SAGENOPTERIS (?) POLYPHYLLA, Fstn., 1880.*1880. *L. c.*, p. 113, fig.*Raniganj group*: Raniganj coalfield.60.—*SAGENOPTERIS comp. RHOIFOLIA, Presl.*1880. *L. c.*, p. 114, fig.*Raniganj group*: Raniganj coalfield.61.—*SAGENOPTERIS (?) STOLICZKANA, Fstn., 1879.*

1879. Gondwána Flora, Vol. III, Pt. 1, p. 18, fig.

Karharbári beds: Karharbári coalfield.Genus: *ACTINOPTERIS, Schenk, 1867.*62.—*ACTINOPTERIS BENGALENSIS, Fstn., 1876.*

1876. Rec. Geol. Surv., India, Vol. IX, Pt. 3, p. 76. 1880. Gondwána Flora, Vol. III, Pt. 2, p. 115.

Raniganj group: Raniganj coalfield.Genus: *ANTHROPHYOPSIS, Nath., 1878.*63.—*ANTHROPHYOPSIS (?) sp.*

1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 116, fig.

Kámthi (Raniganj) group: Kúlácheru, South Godávari district.

II. PHANEROGAMÆ.

*AGYMNOSPERMÆ.*Class: *CYCADEACEÆ.*Order: *ZAMIEÆ.*Genus: *PTEROHYLLUM, Bgt., 1828.*64.—*PTEROHYLLUM BURDWANENSE, Fstn., 1877 (Mc' Clell.).*

1877. Rec. Geol. Surv., India, Vol. X, Pt. 2, p. 71, fig. 1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 116, etc., fig.

Raniganj group: Raniganj coalfield.Genus: *ANOMOZAMITES, Schimp.*Sub-genus *PLATYPTERYGIUM, Schimp.*65.—*PLATYPTERYGIUM BALLI, Fstn., 1885.*1881. Anomozamites balli, Rec. Geol. Surv. of India, Vol. XIV, Pt. 3, p. 256 *et* fig. More figures in the*Barákar group*: Auranga coalfield (Sukri river, west of Gurtur).

Genus : **GLOSSOZAMITES**, *Schimp.*, 1870.

66.—GLOSSOZAMITES STOLICZKANUS, *Fstn.*, 1879.

1879. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 1, p. 19, fig.

Karhárbari beds : Karharbári coalfield.

Order: **NÖGGERATHIOPSIDEÆ**, *Fstn.*, 1879.

1879. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 1, p. 20, *et seq.*; also suppl. to the same, *ib.* p. 55, etc., and all subsequent publications.

Genus : **NÖGGERATHIOPSIS**, *Fstn.*, 1879.

67.—NÖGGERATHIOPSIS HISLOPI, *Fstn.*, 1879.

Literature same as above.

This is a very numerous and widely-distributed fossil in India; the same genus is also found in Australia in the lower and upper coal-measures (Newcastle beds); and there is hardly any doubt that it represents Schmalhausen's *Rhiptozamites* from jurassic beds in Russian Siberia. The same species was also identified from the coalbeds of Tong-King.

Transitional beds : South Rewah (Parsora, near Beli).

Raniganj (Kámthi) group : Raniganj coalfield; South-Rewah basin; Nágpur area.

Ironstone shales : South Káranpura coalfield (Naikori river, near Jainagar).

Barákar group : Káranpura coalfield; Ramkola-Tatapáni coalfield; South Rewah Gondwána basin; Umrét coalfield (near Barkoi, Central Provinces).

Karharbári beds : Karharbári coalfield; Daltonganj coalfield; Mohpáni coalfield.

Talchir group : Karaun (Deoghar) coalfield; Káranpura coalfield; Auranga coalfield (N. base of Latiahár hill).

68.—NÖGGERATHIOPSIS LACERATA, *Fstn.*, 1882.

1882. Pal. Ind.; Gondwána Flora, Vol. IV, Pt. 1, p. 42.

Karharbári beds : South Rewah (Dhamni, south-east of Khaira; this locality is included by Mr. Hughes with the Barákar group).

Squamæ and semina.

There are some other doubtful fossils, which probably are in some relation to the preceding order.

69.—SQUAMÆ GYMNOSPERMARUM, 1880.

1880. Pal. Ind.; Gondwána Flora, Vol. III, Pt. 2, p. 119, fig. Also Vol. IV, Pt. 1, p. 27.

Transitional beds : Auranga coalfield.

Raniganj group : Rájmahál hills; Raniganj coalfield; Káranpura coalfield; Auranga coalfield; South Rewah (Son river).

Barákar group : Raniganj coalfield ; Káranpura coalfield.

Karharbári beds (?) : South Rewah (Dhamni, south-east of Khaira).

70.—CARPOLITHES MILLERI, *Fstn.*, 1879 (1881).

1879. Pal. Ind. ; Gondwána Flora, Vol. III, Pt. 1, p. 30, 1881 Suppl. to the same—p. 59, fig. Also Vol. IV, Pt. 1, p. 43, figs.

Karharbári beds : Karharbári coalfield ; also South Rewah (Dhamni, south-east of Khaira).

Class : CONIFERAÆ.

Order : TAXACEÆ.

Genus : RHIPIDOPSIS, *Schmalh.*

1879. Brdg. z. Jurafl. Russl., p. 50 etc., fig.

71.—RHIPIDOPSIS GINKOIDES, *Schmalh.*

1885. Feistmantel : Gondwána Flora, Vol. IV, Pt. 2 (this Memoir).

Barákar group : Auranga coalfield (Sukri river, west of Gurtur).

72.—RHIPIDOPSIS DENSINERVIS, *Fstn.*, 1880.

1880. Pal. Ind. ; Gondwána Flora, Vol. III, Pt. 2, p. 21, fig. etc.

Raniganj (Kámthi) *group* : South Godávari district (near Kunlácheru).

Genus : EURYPHYLLUM, *Fstn.*, 1879.

73.—EURYPHYLLUM WHITTIANUM, *Fstn.*, 1879.

1879. Pal. Ind. ; Gondwána Flora, Vol. III, Pt. 1, pp. 26-27, fig.

Karharbári beds : Karharbári coalfield.

Order : TAXODINEÆ.

Genus : CYCLOPITYS, *Schmalh.*, 1879.

1879. L. c., pp. 39, 88, etc., fig.

74.—CYCLOPITYS (?) dichotoma, *Fstn.* 1885.

1885. This Memoir.

Barákar group : Auranga coalfield (Sukri river, west of Gurtur).

Genus : VOLTZIA, *Bgt.*

75.—VOLTZIA HETEROPHYLLA, *Lgt.*

1879. Feistmantel : Pal. Ind. ; Gondwána Flora, Vol. III, Pt. 1, p. 28, fig. Also subsequent publications (Vol. III, Pt. 2, p. 122 ; Vol. IV, Pt. 1, p. 43).

Raniganj group : Raniganj coalfield ; South-Rewah basin (Gopat area).

Karharbári beds : Karharbári coalfield ; Daltonganj coalfield ; South-Rewah basin (two places south of Khaira, which, however, Mr. Hughes classes with the Barákar group).

Order: ARAUCARIEÆ.

76.—Genus: ALBERTIA, Schimp.

1879. Feistmantel: Pal. Ind.; Gondwána Flora, Vol. III, Pt. 1, p. 29.

Karharbári beds: Karharbári coalfield.*Coniferous* (? seeds).

77.—Genus: SAMAROPSIS, Heer.

Certain winged seeds, which occur rather frequently at various horizons, resemble very much the above genus.

Transitional beds: Auranga coalfield (north base of Latiahar hill).

Raniganj group: Raniganj field; Káranpura coalfield; South-Rewah Gondwána basin.

Karharbári beds: Karharbári coalfield; Daltonganj coalfield; South-Rewah basin.

Talchir group: Káranpura coalfield (Chano basin); Auranga coalfield; Karaun (Deoghar) coalfield.

B.—ANIMALIA.

The animal-remains in the lower-Gondwána are very much less numerous than the plant fossils; and indeed only one group, the Panchet, yielded several species. All the animals are fresh-water or land forms.

Subkingdom: ANNULOSA.

Class: CRUSTACEA.

1.—ESTHERIA MANGALIENSIS, Jones, 1862.

1862. Palæontogr. Society, London: Monograph of fossil *Estheria*, p. 76, Pl. II, figs. 16—23.

A larger and a smaller form.

Raniganj (Kámthi) group: Shales at Mángli, south of Nágpur; the smaller form also at Káwarsa in the Wardha valley coalfield, in beds that are placed with the Raniganj group.

Quite a similar form also occurs in the Panchet group in the Raniganj coalfield (near Asansol).

Subkingdom: VERTEBRATA.

Class: PISCES.

1861. Rev. Mr. Hislop: Quar. Journ. Geol. Soc., London, Vol. XVII, p. 347.

2.—The only fish-remains in the lower-Gondwána are scales and some other fragments of Ganoid fishes—from Mángli and the Nágpur areas.

Class: AMPHIBIA.

Order: LABYRINTHODONTIA.

3.—BRACHYOPS LATICEPS, Owen, 1855.

1855. Quar. Journ. Geol. Soc. London, Vol. IX, p. 37, Pl. II. 1879. Man. Geo. of Ind., Vol. I, p. 10.

Raniganj (Kámthi) group: Mángli shales.

4.—GONIOGLYPHTUS LONGIROSTRIS, Huxley, 1865.

1865. Pal. Ind., Ser. IV 1, pp. 3—6, Pl. VI. 1879. Lydekker, ib., Ser. IV, 3, p. 17, Pl. III, figs. 14, 15.

Panchet group.—Raniganj coalfield, south-west of Asansol.

FOSSIL FLORA OF THE GONDWÁNA SYSTEM.

5.—*GONIOGLYPTUS HUXLEYI*, Lyd., 1882.

1882. Rec. Geol. Survey of India, XV, p. 26.

Panchet group : Raniganj coalfield.

6.—*PACHYGONIA INCURVATA*, Huxley, 1865.

1865. J. o., pp. 6-7, figs. 1, 2, etc. 1869. Lydekker : l. c., pp. 18-19, Pl. III, figs. 12, 13.

Panchet group : Raniganj coalfield, south-west of Asansol.

7.—*GLYPTOGNATHUS FRAGILIS*, Lyd., 1882.

1882. Rec. Geol. Survey of India, 1882, XV, p. 27.

Panchet group : Raniganj coalfield.

8.—*ARCHEGOSAURUS (?)* sp. ? olim ; now, *Gondwanosaurus bijoriensis*, Lydekker, 1885.

1864. Journ. As. Soc. Beng., Vol. XXXIII, pp. 336, 442. 1873. Archegosaurus, Medlicott : Mem. Geol. Survey of India, X, p. 159. 1875. H. F. Blanford : Qu. Journ. Geol. Soc. London, XXXI, p. 522. 1879. Archegosaurus (?), Lydekker : Pal. Ind., Ser. IV, Pt. 3, p. 36. 1879. Archegosaurus (?) Feistmantel : Rec. Geol. Survey of India, Vol. XII, pp. 76, 78. 1880. Lydekker : Journ. As. Soc. Beng., XLIX, p. 16. 1883. Archegosaurus (provisionally) Lydekker : Rec. Geol. Survey of India, XVI, 2, p. 64. 1885. Gondwanosaurus bijoriensis, n. gen. et sp., Lydekker : Pal. Ind., Ser. IV., pt. 4, pp. 1-16, fig.

I have given the full list of synonyms just to show how doubtful has been the nature of this peculiar fossil ; and even now, I think, with the above name nothing is gained with regard to its systematical position and relations. It is true, it is placed with the *Archegosauria*, but Mr. Lydekker himself adds that it is evidently a more specialised type than *Archegosaurus* (1885, l. c., p. 12), and that the specialisation indicates an approach to the higher labyrinthodonts like *Mastodonsaurus* and *Labyrinthodon*.

Occurrence : The specimen is supposed to come from the *Bijori horizon* (equiv. Raniganj group) : Sátpura basin, near Bijori, upper Denwa valley.

Class : REPTILIA.

Order : ANOMODONTIA.

9.—*DICYNODON ORIENTALIS* : Huxley, 1865.

1865. Pal. Ind., Ser. IV, Pt. 1, pp. 8-11, figs. 1879. Lydekker : l. c., pp. 1-17, figs.

Panchet group : Raniganj coalfield, south-west of Asansol.

10.—*DICYNODON*, sp. 1879.

1879. Lydekker : l. c., Pl. 1, fig. 5.

Locality the same.

Order : DINOSAURIA.

11.—*EPICAMPODON INDICUS*, Huxley, sp. (Lydekker).

1885. Pal. Ind., Ser. IV, Pt. 5, p. 37 (Synon. *Ankistrodon*).

Locality the same.

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<i>Voltzia heterophylla</i> , Bgt.	I 43, II 64
<i>a</i>	I 39, II 36

EXPLANATION OF PLATES.

PLATE I A.

Fig. 1. *MACROTENIOPTERIS FEDDENI*, Fstn., page 24. A large pretty complete specimen, described in the text.

Fig. 2. *GLOSSOPTERIS BROWNIANA*, Bgt., page 28. A specimen showing the venation of this species.

2a. A portion enlarged.

Fig. 3. *GLOSSOPTERIS DAMUDICA*, Fstn., page 28.

3a. A portion enlarged.

All the specimens are from the Barákar group in the Sukri river, west of Gurtur, Auranga coalfield.

PLATE II A.

Figs. 1, 2. *GLOSSOPTERIS COMMUNIS*, Fstm., page 26. Two specimens with a very narrow net-venation.

1 a , 2 a . Portions enlarged.

Fig. 3. *GANGAMOPTERIS*, sp. . 3 a . The same enlarged.

Figs. 4—8. *PLATYPTERYGIUM BALLI*, Fstm., page 37. Various portions of fronds of this very interesting species. Figs. 4, 5, and 8 show the top portions. Figs. 4 a , 7 a , 8 a and 8 b show enlarged leaflets and the distribution of the veins.

All the specimens are from the Barakar group in the Sukri river west of Gurtur, Auranga coalfield.

PLATE III A.

2. *Rhipidopsis GINKGOIDES*, Schmalh., page 43. Several leaves of this Gingkoid plant are grouped close to a stem portion so as to appear as if they belonged to it and to have been attached to it in bunches. To the right of fig. 2 is another figure of *Platypergium ballii*.
3. *CYCLOPITYS (?) DICHOTOMA*, Fstm., page 44. This specimen shows two leaf-whorls, one with five, the other with three leaves, which are twice or ~~three~~ times forked.
4. Another specimen of the same species.

Barákar group, Sukri river, west of Gurtur, Auranga coalfield.

PLATE IV A.

Fig. 1. Left figure : *GLOSSOPTERIS RETIFERA*, Fstn., page 29.
Right figure : *GLOSSOPT. DAMUDICA*, Fstn., page 28. The two leaves are drawn
as presented on the same specimen.

Barákar group, Sukri river, east-by-north of Rajbar, Auranga coalfield.

Figs. 2 and 3. *MACROTÄNIOPTERIS DANÆOIDES*, Royle, sp., page 24. The venation at least is
that of this species.

Figs. 4, 5, 7—11. *VERTEBRARIA INDICA*, Royle, page 22. Specimens showing a peculiar kind of
preservation.

Fig. 6. *CYCLOPITYS (?) DICHTOMA*, Fstn., page 44.
These latter specimens from Barákar group, Sukri river, west of Gurtur, Auranga
coalfield.

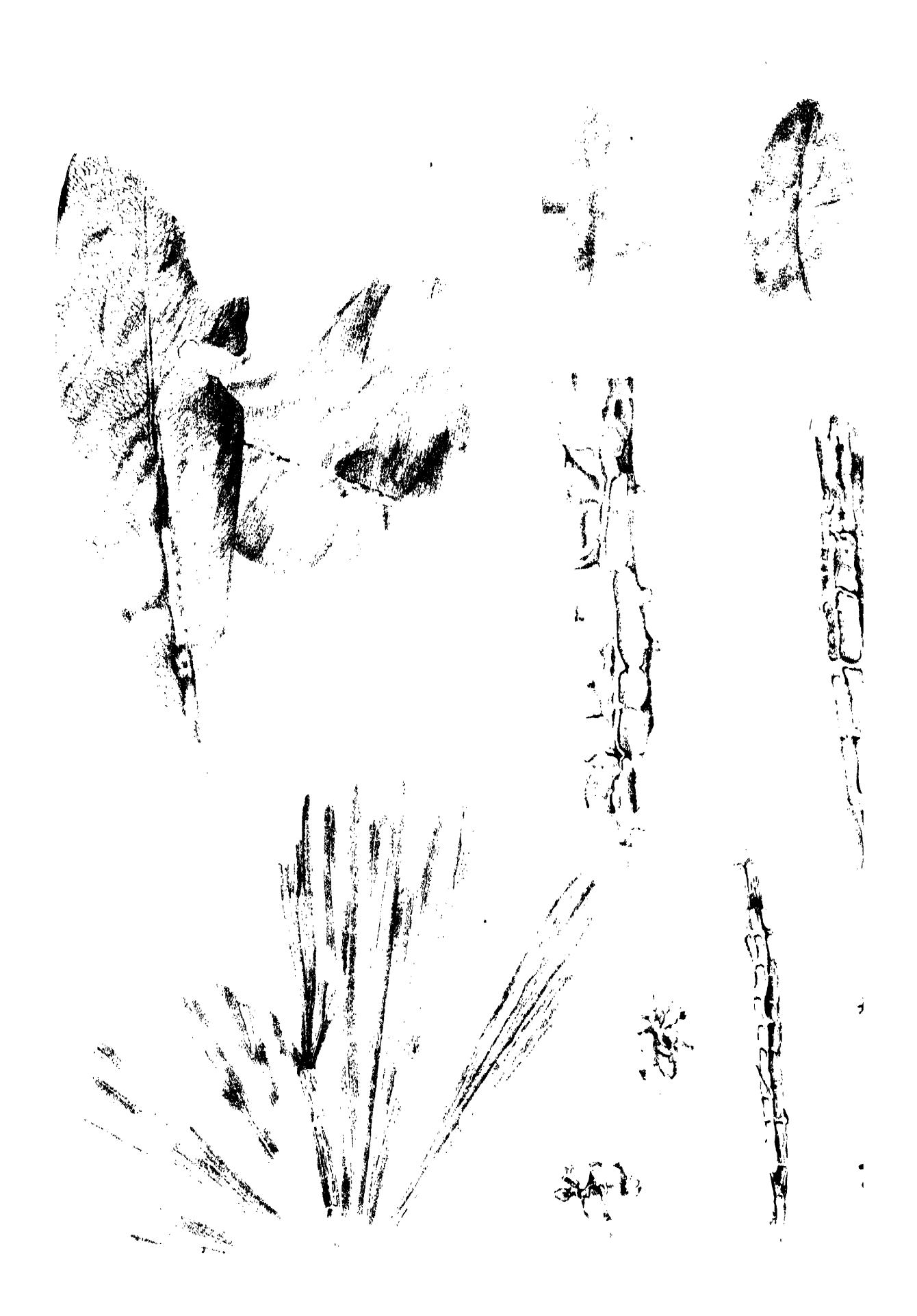


PLATE VA.

Fig. 1. *VERTEBRARIA INDICA*, Royle, page 22. Stem and rootlets.
Barákar group, Sukri river, west of Gurtur, Auranga coalfield.

Fig. 2. *SQUAMA* (*Gymnospermarium*).

Fig. 4. *GANGAMOPTERIS*, (?) *ANTHROPHYOIDES*, Fstm., page 34.

Fig. 5. *GLOSSOPTERIS ANGUSTIFOLIA*, Bgt., page 25.
These three specimens from Raniganj group, west of Burgaon (in Ganeshpur river), Káranpura coalfield.

Fig. 3. *DICRYPTERIDIUM*, page 34.

Fig. 8. *a-e. WINGED SEEDS* : (?) *SAMAROPSIS*, page 45.
From the Raniganj group, south of Tandwa, Káranpura coalfield.

Fig. 6. *GLOSSOPTERIS DAMUDICA*, Fstm., page 28. Fragment of a large leaf.

Fig. 7. *GANGAMOPTERIS*, sp. A small leaf, appertaining apparently to this genus.
These two specimens from Ironstone-shales, near Jainagar (in Naikori river), South-Káranpura coalfield.

Fig. 9. *GANGAMOPTERIS MAJOR*, Fstm., page 33. Top portion.

Fig. 10. *GANGAMOPT. CYCLOPTEROIDES*, var. *SUBAURICULATA*, page 31. Both from Talehir shales, Chano basin, north-west of Rikba, Káranpura coalfield.



PLATE VI A.

Figs. 1 & 2. *GANGAMOPTERIS CYCLOPTEROIDES*, Fstm., page 30.

The typical form, resembling very much those originally figured from the Karaun coalfield.

Figs. 3 & 4. *GANGAMOPT. CYCLOPTER.*, var. *SUBAURICULATA*, page 31. Both these specimens show the doubled-up margin of the leaf.

All from the Talchir-shales, Chano basin (north-west of Rikba), Káranpura coalfield.

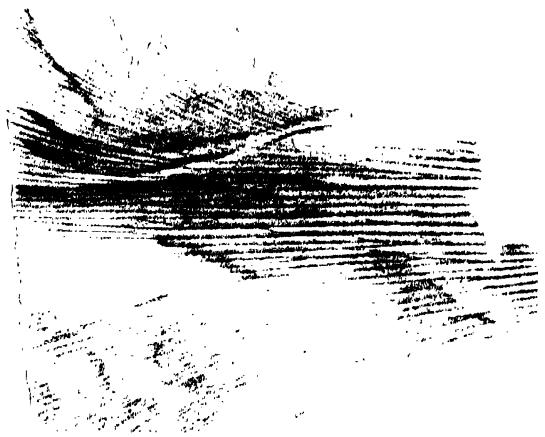


PLATE VII A.

Figs. 1-3, 6. *GANGAMOPTERIS CYCLOPTEROIDES*, var. *SUBAURICULATA*, page 31. Of these, especially fig. 2 shows well the characters of the species.

Figs. 5 & 4 (?). *GANGAMOPTERIS CYCLOPTEROIDES*, var. *ACUMINATA*, page 32.

This appears to be an approximately triangular leaf, consequently with a pointed apex.

All from Talchir-shales, Chano basin, north-west of Rikba, Káranpura coalfield.



PLATE VIII A.

Fig. 1. *GANGAMOPTERIS CYCLOPTEROIDES*, var. *ATTENUATA*, page 32.

Figs. 2, 3. *GANGAMOPT. CYCLOPT.*, var. *SUBAURICULATA*, page 31.
Both specimens showing well the doubling up of the margin.

Fig. 4. *GANGAMOPTERIS CYCLOPTEROIDES*, var. ?

Fig. 5. *GANGAMOPT. CYCLOPT.*, var. *ACUMINATA*, page 32.

Fig. 6. *GANGAMOPT. CYCLOPTEROIDES*, Fstn., page 30. Small specimen of the type form.

Fig. 7. *GANGAMOPTERIS BURIADICA* (?), Fstn., page 33.
All the specimens from Talehir-shales, Chano basin, north-west of Rikba, Káranpura coalfield.



PLATE IX A.

1. *GANGAMOPTERIS CYCLOPTEROIDES*, var. *SUBAURICULATA*, page 31. Specimen with rather thick veins.
2. *GANGAMOPT. CYCLOPTEROIDES*, Fstm., page 30. The type form.
3. *GANGAMOPT. CYCLOPT.*, var. *SUBAURICULATA*, page 31.
The basal portion of the leaf.
- 4a. *GANGAMOPT. CYCLOPT.*, var. *ATTENUATA*, page 32.
- 4, c. *GANGAMOPT. CYCLOPT.*, var. *SUBAURICULATA*, page 31.
All from Talchir-shales, Chano basin, north-west of Rikba, Káranpura coalfield.





PLATE X A.

Figs. 1, 2, 4—7. *GANGAMOPTERIS CYCLOPTEROIDES*, var. *SUBAURICULATA*, page 31.

This is a very instructive series of specimens showing the various states of folding at the margin of the leaf, whereby at last the specimens figs. 2 and 4 were produced:—Figs. 5 and 7 show the beginning; in fig. 6 it is somewhat more advanced, still more so in fig. 1, until in figs. 2 and 4 the margins from both sides meet in the middle line.

These specimens are from Talchir shales, Chano basin, north-west of Rikba, Káranpura coalfield.

Fig. 3. *GANGAMOPT. CYCLOPT.*, var. *SUBAURICULATA*, page 31. A small but very complete specimen, showing well the incut base, and the slightly auricled basal angles.
From Talchir rocks, north face of Latiahar hill, Auranga coalfield.



PLATE XI A.

Figs. 1, 2, 5. **GANGAMOPTERIS CYCLOPTEROIDES**, var. **CORDIFOLIA**, page 32.

1a. a portion of fig. 1 enlarged.

Fig. 3. **GANGAMOPTERIS OBLIQUA**, McCoy, page 33.

Figs. 4 & 7. **GANGAMOPTERIS CYCLOPTEROIDES**, var. **ACUMINATA**, page 32.

Figs. 6 & 8. **GLOSSOPTERIS COMMUNIS**, Fstm., page 26.

The glossopteris character is here quite distinct.

Fig. 9. **GANGAMOPTERIS MAJOI** Fstm., page 33. Somewhat like a leaf of *Nüggerathiopsis*, but the veins forming anastomoses. On the left side the margin is also slightly folded.

All from Talchir shales, Chano basin, north-west of Rikba, Káranpura basin.

PLATE XII A.

Fig. 1. *GLOSSOPTERIS COMMUNIS*, Fstn., page 26.
Fig. 2. *GLOSSOPTERIS INDICA*, Schimp., page 27.
Figs. 3, 4. EQUISETACEOUS OR CONIFEROUS branchlets?
Fig. 5a. *NÖGGERATHIOPSIS HISLOPI*, Fstn., page 40.
Fig. 5b. *GLOSSOPTERIS* (? *communis*)—fragment.
Fig. 6 *a, b.* Fragments of *GLOSSOPTERIS* with a venation resembling (*a*) *Gl. communis* and (*b*) *Gl. indica*.
All these from Talchir shales, Chano basin, north-west of Rikba, Káranpura coalfield.
Figs. 7—15. Winged seeds—*Samaropsis* (compare *parrula*), page 45.
From Talchir shales, Chano basin, Káranpura coalfield, and from northern face of Latiahar hill, Auranga coalfield.
Figs. 16, 18. *GANGAMOPTERIS CYCLOPTEROIDES*, var. *CORDIFOLIA*, page 32.
Talchir shales, northern base of Latiahar hill, Auranga coalfield.
Fig. 17. *GANGAMOPTERIS CYCLOPTEROIDES*, Fstn., page 30.
Same locality as preceding.

$p_1^{(1)}$

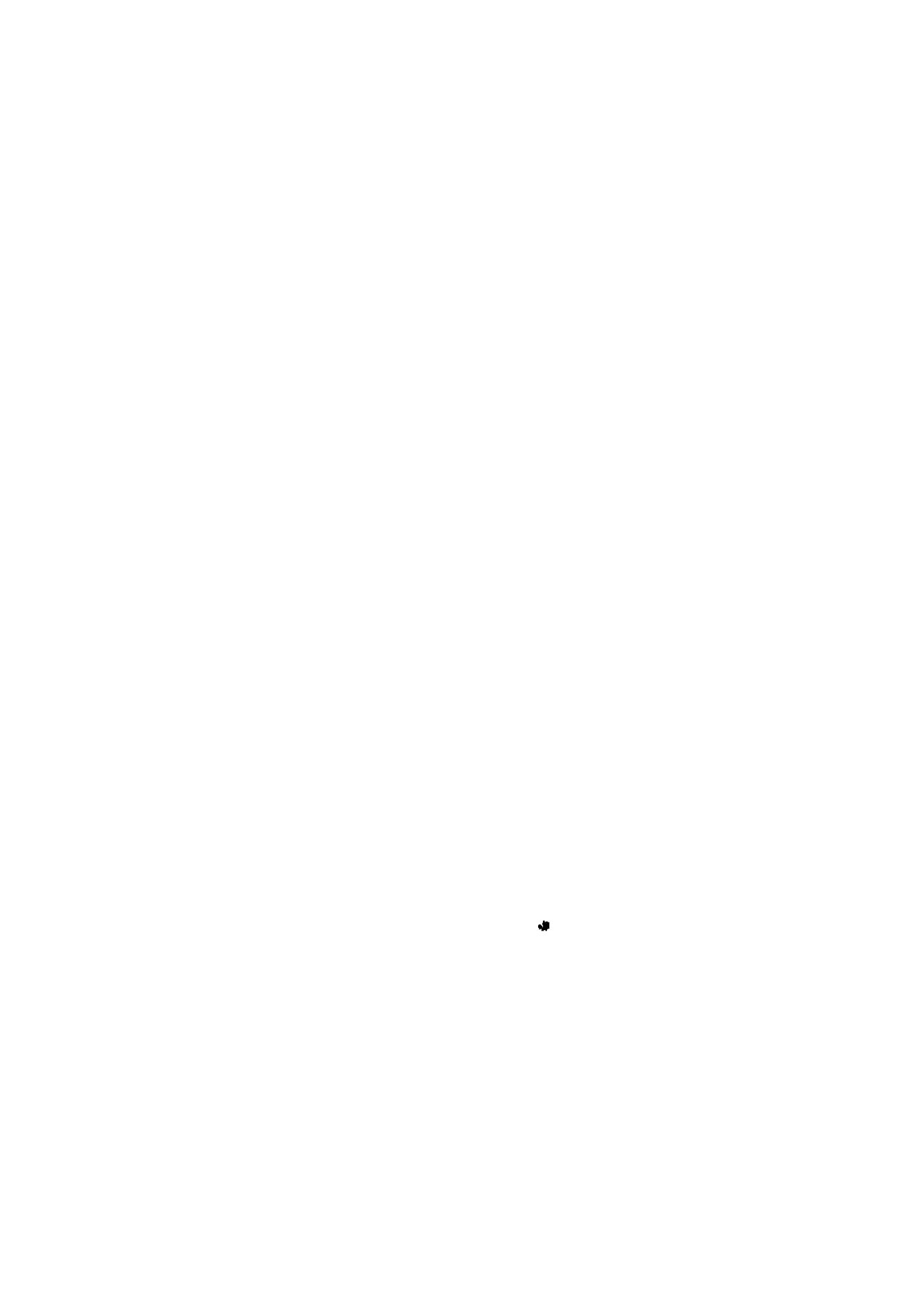


PLATE XIII A.

Fig. 1. *GANGAMOPTERIS CYCLOPTEROIDES*, Fsm., page 30, type .
1a a portion enlarged.

Fig. 2. *GANGAMOPTERIS CYCLOPTEROIDES*, var. *CORDIFOLIA*, page 32.

Figs. 3, 7. *GANGAMOPTERIS CYCLOPTEROIDES*, var. *SUBAURICULATA*, page 31.

Figs. 4, 6. *GANGAMOPTERIS CYCLOPTEROIDES*, var. *ATTENUATA*, page 32.

Fig. 5. *NÖGGERATHIOPSIS HISLOPI*, Fsm., page 40.
All from Talehir shales, northern base of Latabar hill, Auranga coalfield.

Figs. 8—9. *VERTEBRARIA INICA*, Royle, page 22.
Talehir rocks, Belon-Burgon, South-Rewah. The oldest known specimen of *Ver-*
tebraria.

PLATE XIV A.

Figs. 1—4. *GANGAMOPTERIS CYCLOPTEROIDES*, Fstm., page 30. Type form.

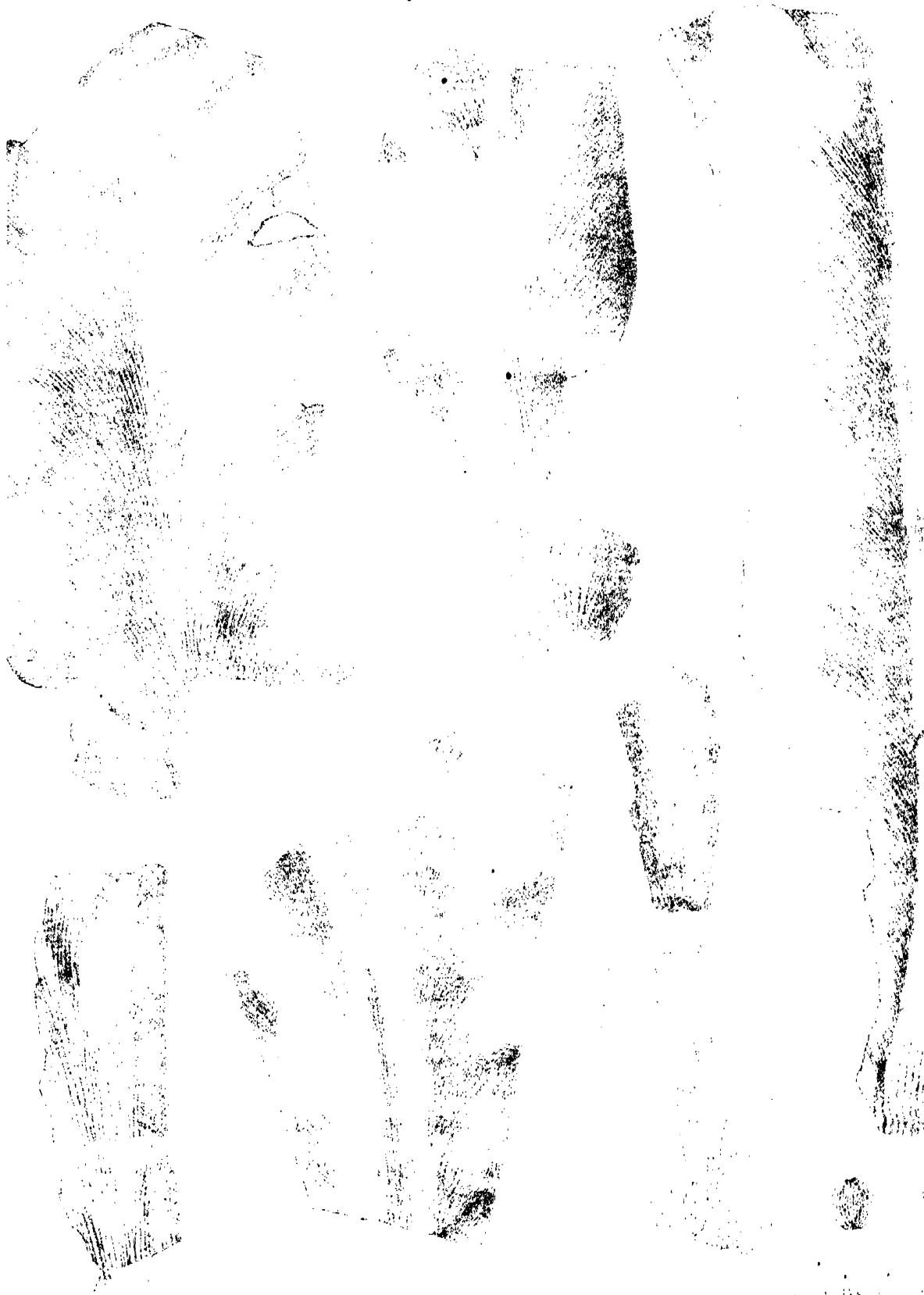
Fig. 5. *GANGAMOPTERIS CYCLOPTEROIDES*, var. *SUBAURICULATA*, page 31.

Fig. 6. *GANGAMOPTERIS CYCLOPTEROIDES*, var. *ATTENUATA*, page 32.

Fig. 7. *GLOSSOPTERIS INDICA*, Fstm., page 27.

Figs. 8, 9. Seeds, page 45.

All from Karharbári beds, outcrops south of Rájhera, Daltonganj coalfield.



MEMOIRS
OF
THE GEOLOGICAL SURVEY OF INDIA.

Palaentolog Indica

BEING

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PROGRESS OF THE GEOLOGICAL SURVEY OF INDIA.

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Ser.

THE FOSSIL FLORA OF THE GONDWÁNA SYSTEM.

Vol. IV.

OTTOKAR FEISTMANTEL, M.D., C.M.R.S., New South Wales, &c.,
Professor, Bohemian Polytechnic University, Prague.

Pt. 1. (1882) : THE FOSSIL FLORA OF THE SOUTH REWAH GOND-
WÁNA BASIN; pp. 1—52; Plates I—XXI.

Pt. 2. (1886) : THE FOSSIL FLORA OF SOME OF THE COALFIELDS
IN WESTERN BENGAL; pp. 1—66; Plates IA—XIVA.

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NOTICE.

(*Vol. IV of the Gondwána Flora.*)

In concluding the fourth volume of his *magnum opus* in the Palaeontologia Indica the author of the Gondwána Flora has certainly a right to give a summary review of the latest discussions upon this very interesting subject. I have, therefore, acceded to Dr. Feistmantel's special request to publish his Introduction in full; only some minor and more or less irrelevant passages have been omitted. I regret that at the same time I should feel it officially incumbent on me, as a duty to others who have taken part in these discussions in the publications of the Survey as well as to students in general, to notice some inaccuracies into which Dr. Feistmantel has fallen in the special pleading for his own views. Having taken no part in the controversy I can assume this office with better grace.

2. It is highly satisfactory that, having contested the operation at every step, Dr. Feistmantel should end by cheerfully conceding the main point at issue: in his tabular statement of the case (p. xxv) the whole lower-Gondwána division (as he constructs it) is placed as palaeozoic. This comes immediately after the emphatic declaration (p. xxiv) that "in spite of all the various attempts at modifications since I left India, there is yet no necessity for any real or important rectification of my previous classification and correlations." Now, Dr. Feistmantel's latest deliverance on this question, a year before he left India, is contained in the following passage, quoted from the last page (132) of pt. 2, Vol. III of the Gondwána Flora (published in September 1881):—"The above-mentioned more recent observations remove now these difficulties to a considerable extent, helping to fix with great probability the position of the lower-Gondwánas; for, taking into consideration the correlation of the Talchir-Karharbári beds with the Bacchus Marsh beds, and of these latter with the Hawkesbury beds, which overlie the Newcastle beds, and considering these latter as permian while the two former are considered as lower mesozoic, then the age of our lower-Gondwánas will have to be approximately the same" (*i.e.*, lower mesozoic). This is the contention that was started by Dr. Feistmantel in 1876 (Rec. G. S. I., IX, p. 79), when the Talchirs with the Damudas were placed by him as triassic, and I can find no departure from it in any of his papers until the present complete renunciation. It is indeed asserted (on p. xiii) that the permian age of the Talchir boulder-bed had previously been freely admitted, but it would seem from a later passage that this admission involved a mental reservation; for (on p. xxi) it is only claimed that "this correlation is one to which in my later writings I have not made any objection." I can find only one passage where even casual allusion is made to

that suggestion, and rather in a tone of dissent than of acceptance, thus : "the correlation of the Indian Talchirs with the Ekka beds in South Africa and with the permian breccia in England is also based upon these similar physical phenomena only" (Rec. XIII, 251 : 1880) ; and in the same short paper the Talchirs are correlated with the Bacchus Marsh and the Hawkesbury beds as mesozoic, as "overlying the Newcastle beds, which represent the close of the palaeozoic rocks in Australia." This would, I should think, be construed as something very like an 'objection ;' and a bitter controversialist must submit to be judged by what he has said, not by what he has avoided saying.

3. After all, the formal adaptation exhibited in the table (p. xxv) would seem to be unreal, for in the text (pp. xiii, xiv) the age of the Gondwána is twice quoted as 'Trias-Jura,' as if this still held good in spite of the recent plunge into the coal-measures. But, perhaps, this is Dr. Feistmantel's way of displaying his adhesion to the paleobotanical standard, the rights of which he so zealously defends with the help of Mr. Zeiller. In any one but a specialist this sort of performance would be unpardonable, for there really is no *casus belli* in the matter. No one objects to the correlation of the several Gondwána floras with the floras of European or other formations; it is the correct thing to be done; to dispute it it would be like getting up a fight over a sum in simple arithmetic; but if those determinations were all as exact as they are asserted to be, they could never be adopted for the standard scale of formations. The great discrepancies in the evidence of age as derived from terrestrial and from marine fossils is admitted; to be comparable throughout, the reference to a standard scale must be made upon the same kind of evidence; and independently of any intrinsic merits of consistency the choice for this purpose must fall upon the marine organisms on account of their greater abundance and distribution. It may be allowed to speak of the Gondwána flora as mesozoic, or Trias-Jura; but the Gondwána period, the duration of the Gondwána system, includes the upper palaeozoic.

4. Dr. Feistmantel seems unable to understand this very simple matter of convention, else he would avoid such criticisms as he indulges in; e.g. (on p. xiv) challenging his imaginary opponents to do the very thing they say should not be done; or (on p. xxi) condemning as unintelligible some of Dr. Waagen's recent suggestions, when he was simply applying this rule: correlating the Talechirs, through the Salt-range boulder-bed, with the marine lower-coalmeasures of Australia; in doing which he did not fail to make the needful explanatory adjustment by inferring that the glacial action was later in Australia than in India. The subsequent removal of this difficulty only justified the correctness of the rule, although making that provisional adjustment "wrong," as Dr. Feistmantel inanely remarks. The same comment would apply to the cavil (p. xix) at Mr. Oldham's provisional acceptance of the Bacchus Marsh and Hawkesbury correlation.

5. Dr. Feistmantel's classification of the Gondwána horizons may serve a transitional purpose, but is hardly likely to last. The characteristic of his Transitional-

ERRATA IN PT. 2, VOL. IV.

There are a few mistakes and omissions in this part, the blame for which falls solely upon myself (O. F.).

On page 2, I have omitted to quote the genus *Glossopteris*, Bgt., from the Talchirs, Chuno basin.

On page 3, line 8 from above, read : Pl. XIA, figs. 1, 2, 5 instead of figs. 1, 3.

On page 3, line 9 from above, read : Pl. XIA, fig. 3 instead of figs. 2, 5.

On page 6, line 12, from above, read : *Gangamopteris anthropoides* instead of *Glossopteris anthrop*.

On page 7, line 2 from below, read : *Jaguldagga* instead of *Taguldagga*.

The same on page 10, line 9 from above.

On page 17, in the general list of fossils, *Glossopt. indica*, Schimp, has also to be quoted as occurring in the Talehir group of the Kárapúra (1st column).

Same page, at *Gangamopt. cyclopteroidea*, there is omitted Pl. XIV A, figs. 1-4.

Same page, at *Gangam. cyclopt.*, var. *sabauriculata* read Pl. XA, figs. 1-7 instead of figs. 1, 2, 4-7; there is also omitted : Pl. XIII A, figs. 3, 7. *

Same page, at *Gang. cyclopt.*, var. *cordifolia* read Pl. XIA, figs. 1, 2, 5 instead of figs. 1-3.

Same page at *Gangam. obliqua*, McCoy, read Pl. XIA, fig. 3 instead of figs. 2, 5.

On page 28, line 23 from above, read *fingered* instead of *simple*.

On page 32, at *Gangam. cyclopt.*, var. *cordifolia* read Pl. XIA, figs. 1, 2, 5 instead of figs. 1, 3; the same on page 33, line 2 from above.

On page 33, at *Gangam. comp. obliqua* read Pl. XIA, fig. 3 instead of figs. 2, 5.

On page 62 read *Gymnospermæ* instead of *A. Gymnosperma*.

PREFACE TO VOL. IV.

THE present volume is made up of two fasciculi, which contain descriptions and illustrations of Gondwána fossils (plants) from various Gondwána basins (see title page).

The first memoir contains descriptions of fossils from the extensive South Rewah Gondwána Basin and is illustrated by 21 plates, containing specimens chiefly collected by Mr. T. W. H. Hughes of the Geological Survey, and partly by Sub-Assistant Hira Lall. The fossils are from both the lower- and upper-Gondwánas, and many of them are of no small interest not only on account of their geographical and geological distribution in that wide area, but also from a palaeontological point of view. Highly interesting in both these respects are the fossils from certain localities, especially *Parsora* near Beli, and *Daigaon* on the Johilla river, and others which yielded a flora of a lower-Gondwána character, while from a petrological point of view they occupy a higher position; all these localities were recently included by Mr. Hughes in his provisional section ‘Supra-Bará-kars’ as merely indicating beds above those under description in his memoir on the coalfields of South Rewah, while I have placed them in a distinct division, under the heading of “Transitional beds” between the lower- and upper-Gondwánas, which, as I have suggested, might eventually be classed as “Middle Gondwánas.”

The second memoir of this volume contains descriptions and illustrations of fossils which I collected myself in 1881 and 1883. The plates, fourteen in number, were drawn and lithographed at the Geological Survey Office, in Calcutta; they are numbered independently from those of the first memoir, but to distinguish them as belonging to the second memoir, I have attached to the plate-number the letter A. The text, however, was not written by me in India, but in Europe. Soon after return from my excursion in 1883, I left for Europe, on two years’ furlough; but various circumstances, beyond my control, especially the protracted illness and eventual death of my father, forced me, greatly

to my regret, to resign my Indian appointment. Through the kindness of Mr. H. B. Medlicott I have received permission to publish the memoir in the *Palaeontologia Indica*.

The memoir deals with fossils mostly from the Lower Gondwána, and some from the interesting Transitional-beds in the Auranga coalfield ; it contains several noteworthy additions to the Gondwána Flora, and enlarges our knowledge of the further distribution of many already previously known species.

I have added a discussion of the various groups of the lower-Gondwána and Transitional-beds and their fossils, as well a systematical review of the lower-Gondwána fossils, a similar review of the upper-Gondwána fossils having been given in Vol. II of the Gondwána Flora.

As an introduction to the volume, I have added some general remarks on the Gondwána system as a whole, especially with regard to its various correlations.

OTTOKAR FEISTMANTEL, M.D.

Prague, August 1886.

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INTRODUCTION

To Vol. IV. of the Fossil Flora of the Gondwána System in India,

BY OTTOKAR FEISTMANTEL, M.D.

Some General Remarks on the Gondwána System.

With the present volume my regular work on the Gondwána-Flora for the Palaeontologia Indica is brought to a close, although I still hope that in course of the extended work of the geologists of the Survey in the several Gondwána basins new material will be collected, which from time to time might be sent to me for determination and eventually for description and illustration, for which act of favour I should feel greatly indebted to the respective authorities.

For the present, however, it will not be out of place to add a few general remarks on the Gondwána system, especially with regard to its correlation with other formations, occasion being taken to notice the publications that have appeared since I wrote last on the subject. For this purpose I must distinctly refer to the definition and characters of the various groups of the lower-Gondwánas, as given in the second part of this volume (herewith published), pp. 47—50; for to these groups chief reference will be made.

The principal question still lies, I think, with the probable age of the system itself, and with its correlations to other formations in Australia, Europe, and elsewhere. I shall not recapitulate here all that I have already written on the subject; I shall only state that, in spite of all recent attempts to modify some of my correlations, none has been conclusive enough; so that I still feel quite justified in holding my own, as will clearly be shown, in the following discussion.

The conclusions in my various writings, briefly expressed, were about the following: from the beginning I thought that the Gondwána system represented the Trias-Jura system of Europe and elsewhere, and that with regard to Australia the Damuda series could not be identified with the Australian lower-coalmeasures, not even with the Newcastle beds.

Later on, however, I admitted freely a permian age of the *Talchir boulder-bed*, then so generally insisted on, as I did not see that this view need affect my further deductions and conclusions: for admitting as correct the above age of the boulder-bed, which lies at the base of the Talchir group, a good deal of time must have elapsed before the Talchir shales, containing fossils, and before the Kar-hárbarí beds, with their coalseams, were deposited, and still more so before the Damudas came on; so that even in this case there would be no objection whatever

to the Damudas and Panchets representing the Trias and the upper-Gondwána the Jura, with reference to European formations.

During my work the comparison with Australia developed in such a way that the Talchirs had to be compared with the Bacchus Marsh beds, both containing a boulder-bed and the same fossils, and further on with the Hawkesbury beds, this however *solely* on the evidence of an ice-formed boulder-bed; from the evidence then available I had to consider the Hawkesbury boulder-bed being the same as the other two—a view Mr. R. D. Oldham so fully adopted in August 1884 in his paper “Some rough notes for the construction of a chapter in the history of the earth.”¹ Should it however be proved that this correlation was not correct, that there is a boulder-bed in the lower-coalmeasures (below the Newcastle beds), which has to be correlated with that in the Talchir group and in the Bacchus Marsh beds, then the correlation of the Gondwánas with the Australian plant-beds will be much easier and much more natural; but it will still appear that the Damudas cannot well be correlated with the Newcastle beds.

My belief is, and I hope to be able to show, that even if the Talchir boulder-bed should eventually be proved to be of upper carboniferous age, there is no natural necessity for the Damuda division being older than Trias, so long as we remember that between the Damudas and the Talchir boulder-bed in India there is a very thick series of Talchir shales containing fossils (but without boulders), and also the very thick series of Karharbári beds containing coal-seams, as established with certainty in the Karharbári, Daltonganj, and Mohpáni coalfields, and with probability in the Hútár and South Rewah coalfields.

Besides the general determination of the age of the Gondwánas (Trias-Jura), I have previously attempted also a further correlation of the various groups with some subdivisions of those two formations; this attempt was severely ridiculed and pronounced premature, but I do not think it was disproved; for to point out certain contradictions in the fossil evidence (which I always admitted) and some inconsistencies in the text, is no positive proof to the contrary. Even with regard to this portion of my work I think that there is no reason why I should give up my previous conclusions, so long as my correlations are not replaced with others from more conclusive evidence. At the end of these general remarks, after discussing some of the papers which have a more or less important bearing on the question, I shall subjoin a table giving a general view of the various possible correlations.

In the first place I have to notice a publication which from my point of view is very important; it was already published in 1882, but I only received a copy of it in 1883, when I came to Europe. It is a paper by Mr. R. Zeiller on the Fossil-Flora of the coalbearing beds of Tong-king.²

¹ Journ. As. Bengal, Pt. II, No. 3, 1884, pp. 7-8 (of the abstract copy).

² “Examen de la flore fossile des couches de charbon du Tong-king,” par M. R. Zeiller, Ingénieur des Mines. Extrait des Annales des Mines; livraison de septembre-octobre 1882. With plates.

The great importance of these fossils lies in the circumstance that, besides a good number of European types of known age, they contain also a number of upper- and lower-Gondwána (especially Damuda) fossils, and all, as it appears, lie on the same horizon, or pretty nearly so. Mr. Zeiller writes (*l.c.* p. 1) with regard to these Tong-king deposits : ".....les couches du Tong-king leur ont fourni un grand nombre d'empreintes en bon état de conservation, qu'il a été possible de déterminer exactement et qui permettent de fixer l'âge de ces dépôts, dans lesquels il n'a été rencontré jusqu'à présent aucune trace de fossiles animaux." This quite justified and generally acknowledged practice of determining the age of beds from plant-evidence only, for which I was so often severely but quite unjustly blamed is here most solemnly affirmed as correct, which I consider as a great satisfaction to me.

The fossil plants of Tong-king come from two basins—that of Hon-Gâc and Ké-Bao, separated by a ridge of carboniferous limestone, upon which the plant-beds lie unconformably.

A third basin, at Lang-Sân, which yielded only three species, *viz.* *Asplenites rösserti*, Presl. (rhætic), *Tæniopteris mc'clellandii* (upper-Gondwánas), and *Poly-podites fuchsi*, Zeill., is here left out of consideration.

With regard to the fossils Mr. Zeiller says (*l.c.*, p. 29) :

".....le tableau qui précède montre que les deux groupes de mines, Hon-Gâc et Ké-Bao, sont liés par plusieurs espèces communes; il serait difficile de tirer de la flore aucune indication sérieuse sur l'âge relatif des couches qu'on y exploite; elles ont trop de caractères communs dans leur végétation pour qu'on puisse les distinguer les unes des autres, et elles appartiennent toutes à une même époque; ce n'est que par l'observation directe qu'on pourra arriver à reconnaître exactement leur ordre de superposition"—And further on p. 30: "En tout cas si les plantes recueillies ne permettent pas de trancher définitivement ces questions de détail, elles donnent du moins des renseignements précis sur l'âge du bassin du Tong-king dans son ensemble."

The fossils described by Mr. Zeiller are the following¹ :—

A. From the Ké-Bao basin in Tong-king :—

- * *Tæniopteris* (*Angiopteridium*) *spathulata*, var. *multinervis* : upper-Gondwánas in India.
- * *Palæovittaria kurzi*, Fstm.: lower-Gondwánas (Raniganj group) in India.
- Dictyophyllum nilsoni*, Schenk: rhætic, in Bavaria and Sweden.
- Clathropteris platyphylla*, Brgt. : rhætic in Europe.
- * *Glossopteris browniana*, Brgt.: lower-Gondwánas in India; lower coal-measures and Newcastle-beds in Australia.
- Pterozamites münsteri*, Schimp.: rhætic in Bavaria.
- Nilsonia polymorpha*, Schenk: very numerous in rhætic beds in Europe.
- * *Nöggerathiopsis hislopi*, Fstm. : lower-Gondwánas and Transitional-beds in India.

- We have thus an association of *four* Gondwána species, *three* of which chiefly occur in the lower portion (Damuda), while the fourth belongs to the upper portion

¹ The Indian forms are marked with a * to the left.

of the system, with *four* other species, which are characteristic of the rhætic formation in Europe.

B. From the Hon-Gâc basin in Tong-king :—

Here the association of rhætic and Gondwâna plants is still more evident.

- * *Phyllothecca indica*, Bünb.: lower-Gondwâna (Raniganj group) in India.
- Asplenites rösserti*, Presl.: rhætic in Europe.
- * *Tæniopteris* (*Angiopteridium*) *spathulata*, McClell.: upper-Gondwâna in India.
- * *Tæniopt. spathulata*, var. *multinervis*: upper-Gondwâna in India.
- * *Tæniopt. (Angiopt.) ensis*, Oldh. & Morr.: upper-Gondwâna in India.
- * *Macrotæniopteris feddeni*, Fstm.: lower-Gondwâna (Barâkar and Raniganj group) in India.

Woodwardites microlobus, Schenk: rhætic in Europe.

Polypodites fuchsi, Zeill.: a new species from the Hon-Gâc basin.

Dictyophyllum acutilobum, Schenk: common in rhætic beds in Europe.

Clathropteris platyphylla, Brtg.: common in rhætic beds in Europe.

Pterophyllum arquale, Nath.: rhætic in Europe.

Pterozamites münsteri, Schimp.: rhætic.

Anomozamites inconstans, Schimp.: rhætic.

Nilsonia polymorpha, Schenk: very common in rhætic beds in Europe.

- * *Otozamites rarinerpis*, Fstm.: upper-Gondwâna (Sripermatur group) in India.

Podozamites distans, Braun: rhætic beds in Europe.

- * *Nöggerathiopsis hislopi*, Fstm.: lower-Gondwâna and Transitional-beds in India.

Cycadites saladini, Zeill.: a new species.

Here we have seven Gondwâna species, three of which occur especially in the lower portion of that system, while four occur in the upper portion, in association with nine species characteristic of rhætic beds in Europe; two species are new.

If we consider the fossils of the two basins together, keeping in mind that their beds are believed to be on the same horizon, then we find an association of *nine* Gondwâna species, *five* of which are especially represented in the lower portion (especially Damudas), while *four* belong to the upper portion of that system, with *ten* species characteristic of rhætic beds in Europe and elsewhere. This is really a most interesting fact, giving also a fresh interest to my previous deductions.

From the fact that there are ten species of rhætic beds, Mr. Zeiller thinks himself justified in placing the coal-bearing beds of Tong-king between the Trias and Jura and to consider them as representative of the rhætic beds in Europe.

But Mr. Zeiller goes on to compare these Tong-king beds with other beds containing related forms, and in the first place with the Indian Gondwâna system. As the Tong-king beds contain lower and upper Gondwâna fossils (five and four), he arrives at the conclusion that the Tong-king beds also take a place between the

lower and upper Gondwáñas, that is to say, between beds which by myself were considered triassic (lower-Gondwáñas) and *jurassic* (upper-Gondwáñas), a place which they occupy also through their *rhætic*-forms. Mr. Zeiller writes, *l.c.* p. 36, thus :—

“ Il résulte de ce qui vient d’être dit que les couches de charbon du Tong-king viennent se placer entre les *Lower* et les *Upper Gondwáñas*, c’est-à-dire entre des couches considérées par M. Feistmantel, les premières comme triasiques, les secondes comme liasiques (en ne parlant du moins que de l’étage de Rajmahal). L’âge déterminé par comparaison avec l’Europe coincide donc avec celui qu’indique la comparaison avec l’Inde, et cette coïncidence vient confirmer les idées émises par M. Feistmantel, sur l’âge de l’étage de Rajmahal, d’une part, et sur celui des Lower Gondwáñas d’autre part.”

Mr. Zeiller was, however, also very well aware of the opposition which my views experienced on the part of Mr. W. T. Blanford, and he therefore proceeds to show in how far other relations, geological and palæontological, would corroborate my determinations. He says distinctly, *l.c.* p. 36 :

“ Toutefois ces idées, au moins en ce qui concerne les *Lower Gondwáñas*, ayant été, de la part des géologues de l’Inde, et particulièrement de M. Blanford, l’objet de critiques assez vives,¹ il me paraît nécessaire d’indiquer comment les dernières recherches, tant géologiques que paléontologiques, viennent à l’appui de ces déterminations.”

He then analyses the fossil floras of Australia, Africa, China, and other parts of Asia, and arrives always at the same conclusion as he had already drawn from the comparison of the Tong-king fossil flora with that of the Gondwáñas and of the rhætic beds, *viz.*, that it takes an intermediate place between Trias and Jura, or else between the lower-Gondwáñas (Damudas) and upper-Gondwáñas.

I consider Mr. Zeiller’s paper as a great satisfaction to myself, with regard to my work on the Indian Gondwáñas.²

We have thus in Tong-king, situated between India and Australia, a flora which mostly agrees with the rhætic flora of Europe, although it contains also upper and lower Gondwána (especially Damuda) plants, some of which also occur in the Newcastle beds and lower-coalmeasures in Australia. It may be that further investigations in Tong-king will allow in time of some stratigraphical differencing of these fossils; but as the case stands at present, the relations are clear and positive and cannot be quietly passed over. They would only show that the Damuda and upper-Gondwána floras belong to the same mesozoic epoch.

Next in order is a paper by Mr. Schmalhausen, entitled “Phytopalaæontologische Beiträge”³ (1883), which has only an indirect bearing on the Gondwána flora, dealing with plants from the Kuznesk basin in the Altai and other parts of Asia.

• ¹ Here he refers to Mr. W. T. Blanford’s paper in Rec. Geol. Surv. Ind., XI (1878), pp. 104, &c.

² In his presidential address (to be mentioned further on) Mr. W. T. Blanford’s summary reflection on Mr. Zeiller’s statements and deductions is that “they show how hopeless is the attempt to classify these deposits by plant evidence alone.”

³ Bulletin de l’Acad. Impér. des Sc., St.-Pétersbourg, T. XXVIII, 1883, pp. 426-438.

INTRODUCTION.

There are, however, several interesting points which deserve a notice here. Mr. Schmalhausen adduces further evidence for the jurassic age of the Altai flora (*l. c.* p. 546). He confirms entirely my views about *Nöggerathiopsis* being closely related, probably identical, with *Rhiptozamites*. He also describes this genus from a lower horizon, *viz.*, from Chara-Tarbagatai in north-western Mongolia, together with *Rhacopteris*, *Lepidodendron veltheimianum*, *Cardiopteris*, etc., an association which strongly reminds one of the same in the lower-coalmeasures (Stony creek, Smith's creek, Greta, &c.) in New South Wales.

Of further importance are certain observations which Mr. Schmalhausen has made in connection with the leaves of his genus *Rhiptozamites* (*Nöggerathiopsis, mihi*) *viz.*, the occurrence of peculiar scales, very similar to those I noticed as "Squamæ" from several places in India (lower-Gondwána), together with "winged seeds" (*Samaropsis*), which also occur in the lower-Gondwána in India in various horizons from Talchirs up into the Transitional-beds. Mr. Schmalhausen thinks that these scales may represent scales of fruitcones, at the base of which the winged seeds were fixed.

In the year 1884 there appeared two papers which deal to a great extent with the Gondwána system. The earlier in date is, I believe, Mr. W. T. Blanford's presidential Address to the Geological section of the British Association, at Montreal (28th August, 1884), subsequently republished¹ under the title: "Homotaxis as illustrated from Indian formations." Although I do not agree with all the conclusions contained therein, I shall not enter into a detailed discussion of the paper, as it does not in the least infringe any of the results obtained by me with regard to the Gondwána system, while at the same time it clearly shows what a difficult position I had when engaged in the working out the Gondwána flora.

I must, however, point specially to one important fact regarding the relations of the Indian Gondwána system to the African Karoo formation, as described in Mr. Blanford's paper. This formation consists (in ascending order) of the Koonap, Beaufort, and Stormberg beds. At the base of these lie the Ecca beds, containing a boulder-bed, apparently formed by ice action, similarly to the Talchir boulder-bed in India; it contains some *Glossopteris*, which we also know from the Talchirs. The Karoo formation is now said to lie unconformably on the Ecca beds, which themselves are said to lie conformably on the underlying palaeozoic strata.²

In the Karoo formation the Beaufort beds are no doubt the closest representative of the Damuda division; and by their stratigraphical position, pointed to so clearly by Mr. Blanford himself, they are much higher in position than the Ecca beds, just as the Damudas are much higher than the Talchir boulder-bed and Talchir shales, above which latter there are still the Karharbári beds.

Now the Ecca beds themselves are stated to lie on palaeozoic strata, containing a flora such as is met with in Europe in middle and in upper coal measures, *viz.*, *Cal-*

¹ Rec. Geo. Surv. Ind., Vol. XVIII, Pt. I, February 1885.

² The above statements are given by Mr. Blanford (*l. c.*, p. 4, 8) as based on the latest information, but without any reference; it is however certain that previous writers were quite positive as to the unconformity between the *Ecca beds* and underlying rocks: see Griesbach still in 1880, Rec. Geol. Surv. Ind., Vol. XIII, Pt. 2, p. 93.

mites, *Asterophyllites equisetiformis*, *Pecopteris cisti*, *Alethopteris lonchitica*, *Lepidodendron*, *Stigmaria*, *Sigillaria*, etc. The Ecca beds, however, although they are said to be conformable on these beds,¹ do not contain any of these or similar fossils, but contain a boulder-bed and a quite different form of plants, *Glossopteris*, which predominates later in the Beaufort beds. It is thus clear enough that rather a great change, both in physical condition and in the flora took place after the deposition of the palæozoic (upper coalmeasures) beds in Africa; and it would really be quite unnatural to maintain that in spite of this the Ecca beds must be of the age of the coalmeasures; it appears to me more natural that, if palæozoic at all, they represent the permian epoch, from which it naturally follows that the Beaufort beds, corresponding to the Damudas in India, are indeed still younger—triassic: the same relations as exist in India.

The second paper of the same year (1884) is one by Mr. R. D. Oldham, Deputy Superintendent, Geological Survey of India, and is entitled: "Some rough notes for the construction of a chapter in the history of the earth."² Mr. Oldham dwells at first at some length on a subject that is also discussed in Mr. Blanford's paper, *viz.*, the preference which marine animal fossils should deserve in comparison with the terrestrial fauna and flora. Several statements and quotations, especially from my works, would admit of rectification, but I have no intention to undertake it. I only want to call attention to the fact, that in August 1884 Mr. R. D. Oldham was, with regard to the Australian flora, especially with regard to the boulder-beds, of quite a different opinion to that expressed in his later paper on the same subject (to be mentioned further on); he was indeed much more positive than myself, especially on the correlation of the Hawkesbury boulder-bed with that of the Bacchus Marsh beds. At that time he of course had no knowledge of the existence of a boulder-bed in the lower-coalmeasures in Australia, and had only such information at his disposal as lay also before me when I wrote my last notes on the correlation of these beds. The description of the relations in the manner then given, especially the fact then admitted by himself, that "the Damudas must be of very much later date than the Newcastle beds," gave him at least an opportunity of trying "to explain why it is that the Newcastle flora left Australia when it did, and why it or its descendants lingered on in India, and spread over what is now the Old World producing important modifications in its flora."³ Any one knowing only this paper on the correlation question, would of course be quite convinced that the Talchir, the Bacchus Marsh, and the Hawkesbury boulder-beds were contemporaneous, and that therefore the Newcastle beds, from their stratigraphical position, are older than the Damudas, a fact which I even now maintain in spite of the modifications to be mentioned.

In the number of Records⁴ containing Mr. W. T. Blanford's presidential Address there is a paper by Mr. Griesbach, entitled "Afghan field notes," in which

¹ Compare, however, the conformable position of permian on carboniferous in many parts of Europe.

² Journ. As. Soc. Bengal, Pt II, No. 3, 1884. Received August 30th, read September 3rd, 1884.

Both quotations are in the Abstract copy, on p. 9 (p. 193 of the Journal).

Vol. XVIII, Pt. I, 1885, pp. 57, etc.

Mr. Griesbach describes certain beds corresponding, as he believes, with the Indian Talchirs and Gondwána beds. The same subject is treated on more completely in a subsequent number of the Records,¹ from which I shall quote some of the more important statements. The paper is entitled "Afghan and Persian field notes," and refers to districts in the Herat valley and in Khorassan. Mr. Griesbach observed there various formations, ranging from carboniferous up to post-tertiary, with some other beds yet below the carboniferous. Of chief importance in this series is however a sequence of 'plant-bearing beds' lying above the carboniferous and to a great extent representing the Indian Gondwána system. On page 49 (*l. c.*) Mr. Griesbach gives a general table of the formations, from which the following observations are taken.

Above the carboniferous there are other beds, containing animal and plant-fossils; Mr. Griesbach thinks that they probably represent the Indian Talchirs, and he classes them as permian and trias. There are other newer strata, rhätic and jurassic, containing (besides others) plant-fossils of Gondwána character (higher than Talchir); Mr. Griesbach mentions distinctly *Glossopteris* from these beds. Hitherto these notes are only very scanty; but they are fully deserving that proper notice should be taken of them. This grouping agrees on the whole with the correlation proposed by myself previously for the various groups of the Gondwána system.

By a strange coincidence the same number of Records² in which Mr. Griesbach's second paper appears, contains two other papers wherein an attempt is made to establish a much lower position of the Talchirs, consequently of the Damudas; one is by Dr. Waagen, the other by Mr. R. D. Oldham. Dr. Waagen's paper is entitled "Notes on some palaeozoic fossils recently collected by Dr. H. Warth in the Olive group of the Salt-range." As Dr. Waagen extended his conclusions to the Gondwána system and its correlations, I do not think anybody will blame me for making a few remarks on this part of the subject.

The starting point of Dr. Waagen's paper was, to show that a certain boulder-bed at the base of the "Olive group," which is of cretaceous or lowest eocene age, has now to be separated from that group and to be considered as palaeozoic, on account of the occurrence of certain pebbles at the top of the boulder-bed containing palaeozoic fossils, especially species of *Conularia*; there are also some other fossils indicating an upper carboniferous age (horizon of the coalmeasures). From Dr. Warth's specimens, the pebbles were declared by Dr. Waagen to be concretionary, and *in situ*; whereby the whole boulder-bed would be of the same age. From abundant evidence the boulder-bed is accepted as having been formed under the influence of ice action.

To the further conclusions, with regard to the age of the Talchirs and Gondwánas and their correlation with certain Australian beds, I have to add a few explanations. On page 34 of his paper (*l. c.*) Dr. Waagen writes: "The most probable conclusion to which Mr. Blanford at last arrives is to consider these beds [Talchirs]

¹ Vol. XIX, Pt. I, 1886, pp. 48, etc.

² Rec. Geol. Surv. India, XIX, Pt. I, 1886.

as of permian age . . . etc." This correlation was first suggested by Mr. H. F. Blanford,¹ and it is one to which in my later writings I have not made any objections.

On the same page Dr. Waagen goes on to say : "All authors were however quite agreed upon one point, that these beds [the Talchirs] had to be compared with certain beds occurring in Australia, in which a number of species of plants which had been found in the Talchirs and Damudas of India also occurred." Dr. Waagen was perhaps at liberty to start from the one point needed for his exposition, but so blank a statement is distinctly misleading, and I deem it necessary to mention that it was the *Damuda division* which, before the Talchir and Karharbári flora became known, was compared with the Newcastle beds in Australia, and as these were said to be in close connection with the lower-coalmeasures, then the Newcastle beds themselves and also the Damudas were considered to be of the same age. The Talchir flora, on the other hand, was only made known after I came to India, although a few specimens were collected before; and the Karharbári beds and flora were solely established through my work (1877 ; see pt. 2 of this volume, p. 48). I was also the first to compare this Talchir flora (and this only) with that of the Bacchus Marsh beds in Victoria ; only later the boulder-bed in the latter was also taken into proper consideration, especially with regard to the corrolation of these beds with the Hawkesbury beds, in which also a boulder-bed of the same nature was said to occur (this at least was my information at that time).

Dr. Waagen may of course be quite right in correlating the Salt-range boulder-bed containing concretions with carboniferous fossils to the lower-coalmeasures with similar fossils in Australia ; but he was hardly at liberty to correlate these with the Talechir-Karharbári beds, while acknowledging (on the same page) that a boulder-bed formed by ice action occurred only in the Hawkesbury and Bacchus Marsh beds, both of which he declares higher than the Newcastle beds and of permian age ; for it is *only* with the Bacchus Marsh beds our Talchirs can in any way be compared. At p. 35 (*l. c.*) Dr. Waagen writes : "Of the Australian beds that can be compared to different members of the Gondwána system of India, it is chiefly the 'lower-coalmeasures with marine layers interstratified' which must be placed homotaxially on the same level as the Talechir-Karharbári beds of the Indian Peninsula or the boulder group of N. W. India. In these beds in Australia traces of ice action have not yet been observed.² The Newcastle beds which follow next above can perhaps not be separated from the preceding ; but the Hawkesbury and the Bacchus Marsh sandstones must certainly be placed on a level with the permian of Europe." It is, at least to me, quite unintelligible how the same Talchirs, which both by the boulder-bed and fossils can with safety be correlated with the Bacchus Marsh sandstones only, should be placed on the horizon of the lower-coalmeasure, while at the same time the Bacchus Marsh beds and Hawkesbury beds, which latter lie above the Newcastle beds, are placed together on a higher level. Dr. Waagen did not take any notice of

¹ Quart. Journ. Geol. Soc. London, 1875, Vol. XXXI., p. 528.

² See further Mr. Oldham's paper, where the contrary is proved, so that all further deductions based on this circumstance are of course wrong.

the close correlation of the Talchirs with the Bacchus Marsh beds, which however cannot be left out of consideration, as it is the only natural correlation.

Even if Dr. Waagen's proof were accepted that the Talchir boulder-bed is of the same age as the boulder-bed in the Salt-range and the lower-coalmeasures in Australia, the further conclusions he draws from this would not stand. If the Talchir boulder-bed really is of the age of the lower-coalmeasures, there are still the Talchir shales and Karharbári beds which are higher and cannot be overlooked; and only then the Damúdas come in. Nor can it be correct to separate, as Dr. Waagen (*l. c.* p. 35) does, the Panchets from the Damúdas, and to join them with the Rajmaháls in one division; for not only is the palaeontology of the latter two different, but also their stratigraphy is opposed to it.

On the same page (35) Dr. Waagen refers to the correlation with the South African formations, and says: "For us at present it is quite sufficient to state that with all possible probability the Ecca conglomerates can be considered as the equivalents of the Talchir boulder-beds and of the Salt-range boulder-groups and are thus of the age of the coalmeasures." This, however, seems scarcely possible; for, as I have stated already, the Ecca conglomerates rest upon strata which themselves are of the age of the coalmeasures, containing a true coalflora, while nothing of the sort is contained in the Ecca beds, which on the contrary yielded a quite different flora. No doubt Dr. Waagen speaks here of the boulder-beds only; and taking it as base of comparison it will be seen that my correlations were not so very far from the reality.

Dr. Waagen's further deductions and conclusions as to the existence of former continents, their configuration, river system, glaciation, etc., are too speculative and I am not at all prepared to follow them up.

I now turn to the last paper to be considered here, *viz.*, Mr. R. D. Oldham's "Memorandum on the correlation of the Indian and Australian coal-bearing beds."¹ I have already explained what my standpoint was in this matter: when I left India the Talchirs were correlated with the Bacchus-Marsh beds from the evidence of the fossils and the boulder-bed, and these with the Hawkesbury beds from the evidence of a boulder-bed only, which was then thought to be of a like glacial origin; thus the difference of the Damudas and Newcastle beds was at once evident as the Hawkesbury beds overlief the latter.

After visiting Australia in 1885. Mr. Oldham, in the paper quoted, adheres to the correlation of the Bacchus Marsh beds with the Indian Talchir beds on the evidence of their fossils and the boulder-beds formed by action of floating ice; but he rejects the correlation with the Hawkesbury beds, which I established on the supposed occurrence of a similar boulder-bed in the latter. Mr. Oldham however shows that there is, it is true, a conglomeratic bed in the Hawkesbury beds which may have been formed by the action of ice in some form, but that it is not comparable with proofs of glacial action exhibited by the Bacchus Marsh beds (*l. c.* p. 43). He shows, moreover, that there are in the upper and lower marine beds (below the Newcastle beds) conglomeratic beds which are strictly comparable with those of the

¹ Rec. Geol. Surv. Ind., Vol. XIX, Pt. I, 1886.

Bacchus Marsh beds, and as the Talchirs and Bacchus Marsh beds must be correlated with each other, Mr. Oldham arrives at the quite natural conclusion that the carboniferous marine beds of New South Wales are the most probable equivalents of the Bacchus Marsh beds of Victoria and hence of the Talchirs of India. So far there is no objection to Mr. Oldham's statements ; but the further conclusion does not seem to me natural.

If the upper and lower marine beds are equivalents of the Talchir boulder-bed, that means to say, if they are formed by the same cause and reason, then we can in the next line only compare beds immediately above both. In New South Wales we have above the upper marine beds the Newcastle beds ; in India there are above the boulder-bed at first the Talchir shales and then the Karharbári beds, and these have certainly, in the natural course of comparison, to be correlated with the Newcastle beds, a correlation also justified by palæontology, for it is in the Talchirs and Karharbáris that *Gangamopt. angustifolia* occurs, and not in the true Damudas as stated by Mr. Oldham (*l. c. p. 47*), and we find it also in the Newcastle beds. The further distribution of the flora is not opposed to these correlations : although of course the similarity between the Damudas and the Newcastle beds cannot be denied, yet from the stratigraphical relations mentioned above, these two can hardly be correlated. But also the further stratigraphical relations speak against it. Above the Newcastle beds we find the Hawkesbury beds ; between these and the Newcastle beds there is an unconformity (Oldham : *l. c. p. 46*), while the latter are said to be conformable on the upper marine beds. In India the Damuda division is also sufficiently marked off from the Talchir division and is by all means a higher series of beds. Upon the Hawkesbury beds there follow in Australia in close connection the Wianamatta beds ; similarly as in India the Panchet division upon the Damudas : I therefore think that from the foregoing reasons it is clear enough, that even after Mr. Oldham's important discovery and proof of the occurrence of a boulder-bed in the lower and upper marine beds in Australia it is not necessary, in fact not natural, that the Damudas should be correlated with the Newcastle beds. Indeed, it is only just to state that Mr. Oldham himself at the end of his interesting and important paper (*l. c. p. 47*) gives various reasons, which "would indicate that the latter [Damudas] was probably of somewhat later date than the Newcastle period."

It appears, however, that the glaciation in those beds, as now established, is much more in accordance with the natural course of things. Both in Africa and Australia there is a carboniferous flora in beds below the horizon containing a boulder-bed formed by ice action ; in Australia there is a lower carboniferous, in Africa a true coal-measures flora ; the most natural inference now is that by the climatal changes which brought on the extended glaciation, the carboniferous flora died out, and after the abatement of the cold a quite different flora appeared, which is that of the Newcastle beds, Bacchus Marsh beds, of the Talchir and Karharbári beds, and in the Ecca beds. In Australia it would appear that the changes came on earlier and repeatedly, so that, although we have there a lower carboniferous flora, no coal-

measure flora could develop, while in Africa it is present. Why there is no coal-measure flora in India I am not prepared to account for. Now in Australia, in the Hawkesbury beds, there are again certain deposits, which, as acknowledged by Mr. Oldham himself (*l. c.*, p. 43), cannot be accounted for except by the action of ice in some form or other, and which therefore would again point to some climatal changes; besides this other changes seem to have taken place, as the unconformity and the greater number of fishes in the Hawkesbury beds indicate, in consequence of which changes probably the Newcastle beds flora died out and could not continue into the Hawkesbury beds; this supposition is also supported by the great gap after the Bacchus Marsh beds; while in India the flora continued into the Damúdas and even Panchets, and in Africa into the Beaufort beds.

The foregoing remarks show, I believe sufficiently, that in spite of all the various attempts at modifications since I left India, there is yet no necessity for any real or important rectification of my previous classification and correlations.

To sum up. 1. We have seen that the Tong-King flora has an important bearing on the Gondwána flora, as taking its place between the lower- and upper-Gondwánas, containing forms of both these divisions and being of rhætic age.

2. The South African relations show, that the Ecca beds being deposited upon coalmeasures cannot themselves be of that age; or if the deposition began in that time, they really also comprise the permian epoch, and thus the Beaufort beds are higher. The Ecca beds are equivalents of the Talchir boulder-bed and the Beaufort beds of the Damudas.

3. The Salt-range case is interesting for itself; but from Mr. Oldham's note it appears that some of the premises were not correct, and thus the conclusions are not safe; but even if the Salt-range and Talchir boulder-beds should prove of the same age, I have shown how still the Damuda are younger.

4. In Afghanistan and Khorassan, there is a great extent of plant-bearing beds, which are above the carboniferous, and the lower portion of which (=Talchirs) is classed by Mr. Griesbach as permian—the others must therefore follow.

5. In Australia there are ice-formed deposits in the lower and upper marine beds. Here it appears the glaciation took place somewhat earlier, and to a certain extent therefore the Australian marine beds certainly replace also the upper coal-measures of other countries, while the Newcastle beds probably represent the greater part of the permian. This inference also follows from the comparison with the boulder-bed in the Salt-range (supposing this to be correct), containing the concritions with palæozoic fossils; this boulder-bed is said to be of the age of the coalmeasures of Europe and elsewhere, and as the Australian beds (lower and upper marine beds) have to be correlated with it, they are of the same age and therefore the Newcastle beds are higher.

6. From all that I have said in the foregoing pages, I offer the following diagram exhibiting all the most possible correlations of the various beds in India, Africa, Afghanistan, further India, Australia, etc. To meet all eventualities I take the Salt-range boulder-bed as of the age of the coalmeasures.

Table exhibiting correlations of the various beds in

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